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EDWARD HYATT, State Engineer

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PIT RIVER INVESTIGATION

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ACKNOWLEDGMENT

In making the Pit River Investigation, the Division of Water Resources was assisted by practically every rancher and landowner in the upper Pit River watershed. The assistance derived from these contacts was invaluable in conducting the field work and in securing the desired data. Appreciation of their cooperation is hereby acknowledged.

Special mention is made of the valuable assistance rendered by Messrs. Peter Gerig, Frank McArthur, T. A. Walls, J. T. Negley and W. J. Dorris, in organizing the field investigation. Mr. George Cline, Modoc County Surveyor, furnished the Division's engineers with the facilities of his engineering office in the courthouse until a headquarters office for the investigation was established.

Acknowledgment is made of the assistance and technical advice given by Mr. H. D. McGlashan, district engineer of the U. S. Geological Survey, Water Resources Branch, and his assistant, Mr. R. C. Briggs, in the initial work of locating suitable sites for the stream gaging stations in the area.

During the course of the investigation valuable assistance and cooperation was obtained from Mr. F. P. Cronemiller, Jr., supervisor of the Modoc National Forest; also from his assistant, Mr. W. S. Brown, and other members of his staff. Mr. J. A. Quinn, manager of the local interests of the California Public Service Company, likewise materially assisted with the work of the investigation in continuously maintaining the stream gaging station on Pine Creek near Alturas. Mr. J. H. Hunter, chief engineer of the Red River Lumber Company, and other employees of that company cooperated in the work by assisting in the maintenance of the stream gaging station on Horse Creek below Little Valley. Assistance in making ditch flow observations was given by Mr. A. F. Spicer, and the sons of Messrs. Charles Bettandorf, Joseph Royce, and Roy Williams.

As a contemporaneous study cooperating with this investigation, the Bureau of Soils of the U. S. Department of Agriculture and the University of California Agricultural Experimental Station made a complete soil survey of the agricultural lands in the upper Pit River watershed and also in the Goose Lake and Surprise Valley areas, in 1931. Certain advance data collected by this soil survey were made available to the Division by those agencies, which proved valuable as a basis of determination of the extent of agricultural lands in the Pit River area as shown in this report. The Big Valley area was surveyed by the Bureau of Soils in 1920, and the results were available in the report entitled "Soil Survey of Big Valley," published by the U. S. Department of Agriculture in 1924.

Valuable maps and records were furnished by the Southern Pacific, Western Pacific, and Great Northern railroad companies, and by the Pacific Gas and Electric Company. Messrs. A. M. Green and Max

Green furnished a complete topographic map of their survey of the Pit River Canyon in the vicinity of Stonecoal Valley. Mr. J. C. Jarman of Alturas furnished lengthly records of temperatures at Alturas.

Special mention is also made of the members of the Permanent Committee, and of the Big Valley and Hot Springs Valley water users' committees, who contributed to the investigation the benefits of their wide knowledge of local conditions and of their experience in water matters.

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FOREWORD

This bulletin comprises the final report on the three-year investigation of the upper Pit River stream system, made pursuant to the agreements entered into on November 13, 1928, and on November 14, 1928, between the Division of Water Resources, Department of Public Works, State of California, and the boards of supervisors of Modoc and Lassen counties, respectively; and pursuant to the request of the Department of Finance, State of California, under authority of section 2, chapter 286, Statutes of 1927.

The report presents the data collected during the investigation, together with the results and conclusions drawn from a study of the data and of other information obtained by prior investigations. A series of analyses pertinent to various of the proposed water conservation projects are presented to show their relative feasibility.

PIT RIVER INVESTIGATION

By Gordon Zander *

CHAPTER I

INTRODUCTION, SUMMARY AND CONCLUSIONS

The valleys of the upper Pit River watershed are devoted almost exclusively to agricultural pursuits which require irrigation for success. Since the areas now irrigated utilize practically the entire natural flows of the contributory streams, future agricultural expansion in these valleys will be dependent upon further conservation and development of their water resources. With the matter of devising a coordinated plan for the development of the water resources of the entire State prominently before the State Legislature, information relative to the water resources of the upper Pit River area, the possibilities for further conservation and development of these resources, and the probable extent of their ultimate utilization within the watershed are of immediate interest.

History of Water Development in Area.

Prior to settlement by whites, the upper Pit River area was inhabited by the Pits and Modocs, warlike tribes of Indians, who were responsible for many raids and massacres of emigrants passing through the territory on their way to Oregon or the California gold fields. No general movement toward settlement of the region was made until after the close of the Modoc Indian Wars in 1873.

The first settlements were made on the Pit River in about 1870 or 1871, in the vicinity of Likely and in Big Valley. The settlers were attracted to the region by the abundant growth of grasses in the meadows adjacent to the streams and by other conditions favorable to stock raising, which became and has remained the predominant industry in the area. Production of hay, pasturage and other stock feeds for consumption in this industry is the basic agricultural activity.

Water development was commenced almost immediately after the first settlement. Due to the ease with which the streams could be diverted and to the small financial outlay required, these early developments were made by individuals or small groups of individuals, and this method has prevailed up to the present time. Except in one instance—the construction of Big Sage Reservoir by the Hot Spring Valley Irrigation District—there has been no construction of community projects within the area. Construction of the East Side and West Side canals about 1900, by means of which the South Fork Valley was reclaimed, is a monument to the boldness of the individual who planned and financed the project.

The development of the water supply of the upper Pit River area has progressed through two distinct stages. In the early days crude irrigation works were constructed to spread the natural flows of the streams over wider areas. Thus lands not previously naturally watered during the spring and summer seasons were made to produce luxuriant

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growths of natural meadow grasses. Also, the lower lying bottom lands which were perennially in a swampy condition were wholly or partly reclaimed to produce a good grade of grass. By 1900 such irrigation systems and methods of irrigation had become firmly established, and the average natural flows of the streams during the irrigation season had become fully utilized in irrigating the flat floors of the valleys.

The second stage in the water development has occurred since 1900, during which period many reservoirs have been created by the construction of storage dams to impound the melting snow flood flows for use for stock water and supplemental irrigation supply. This storage development, although of decided economic value, has resulted in only a relatively small increase in the irrigated acreage.

Prior Investigations

During the period from 1903 to 1915 a series of investigations were made which covered the area under consideration, either in whole or in part. These early investigations were made for the purposes of determining power development possibilities, and the feasibility of storage for flood protection or a supplemental irrigation supply for the Sacramento Valley. Chief among the prior investigations are the following:

A study of the feasibility of five reservoir sites; viz, Jess Valley, West Valley, Warm Springs Valley (Hot Springs Valley), Round Valley, and Big Valley, made by the United States Reclamation Service in 1903 and 1904. The results of that study are published in the 1912 Report of the State Water Commission of California.

A compilation of information relative to the general development of the Pit River basin, including data showing the extent of irrigated areas, crops, and water resources, made in 1912 by the United States Department of Agriculture with the State of California cooperating. This is published in the 1912 Report of the Conservation Commission of California (see pages 110 to 116, inclusive), and also in Journal Appendix of California Senate and Assembly, Fortieth Session—1913, Volume 3.

A hydrographic investigation of the entire Pit River basin, made in 1914 and 1915 by the United States Reclamation Service in cooperation with the State of California. The data obtained in that investigation, as well as the pertinent data contained in the earlier reports, were published by the State of California as "Report on Pit River Basin" by Engineers E. G. Hopson and O. W. Peterson, dated April, 1915.

Records of the flow of Pit River and various of its tributaries at a number of stations within the area under consideration have been obtained by the Water Resources Branch of the United States Geological Survey, and are published in Water Supply Papers as hereinafter noted under "Scope of Report." All of the Geological Survey stations were discontinued prior to the commencement of this investigation, with the exception of the station on Pine Creek near Alturas.

Origin and History of Present Investigation.

The need of furnishing an additional irrigation water supply to the developed lands in the area, and the urgency for the solution of

that problem, became apparent during the dry years following 1923. Repeated partial failures of the natural irrigation supplies during the peak of the growing season made it of paramount importance to seriously consider plans for further water conservation.

Requests for a hydrographic investigation by the Division of Water Rights, covering that portion of the Pit River stream system within Modoc and Lassen counties, were made in April, 1928; coming from the Modoc people through the Modoc County Development Board, and from the Lassen people through their county board of supervisors.

Following a preliminary field investigation and report by the Chief of the Division, formal authorization for the State to contribute funds toward the investigation was received from the Director of Finance on June 16, 1928. It was thereafter agreed that the two counties would contribute a total of $5,000 per year for three years, two-thirds of which to be borne by Modoc County and one-third by Lassen County, and that the State would bear the balance of the cost of the investigation.

On November 13, 1928, and November 14, 1928, the boards of supervisors of Modoc and Lassen counties, respectively, executed agreements with the State Division of Water Rights providing for "a comprehensive survey for the purpose of determining various factors involved in the conservation of the flood waters of Pit River and its tributaries originating in the counties of Modoc and Lassen, State of California" by the Division in consideration of the continuation of the above mentioned annual appropriations by the counties for a period of three years. Copies of the agreements are submitted as Appendices A and B to this bulletin.

Following the execution of the agreements by the two counties a resident engineer with headquarters at Alturas was appointed, and the work was formally commenced about the middle of November, 1928. Certain preliminary work in starting stream gaging stations had been done during October in order that as much as possible of the 1928–29 season's run-off could be recorded.

The construction and installation of the equipment at the major stream gaging stations was completed during the latter part of December, 1928, and continuous records of stream flow were obtained from all of these stations after January 1, 1929. From that time on during the ensuing three years the field work of the investigation was carried on to include the collection of comprehensive hydrographic data in the area.

Immediately following the conclusion of the field work on September 30, 1931, arrangements were made with three of the cooperative weather station observers to continue their stations, without compensation, as a part of the Snow Survey activities of the State Division of Water Resources, and arrangements were also made with the Water Resources Branch of the United States Geological Survey to take over and continue the maintenance and operation of four of the critically located stream gaging stations. The climatological stations continued are at Alturas, Jess Valley, and Bieber. The stream gaging stations continued are on the South Fork of Pit River above Likely, on the North Fork of Pit River above Alturas, on Pit River below Canby, and on Ash Creek at Adin.

Scope of Investigation.

The field investigation was planned and executed with two main objectives:

1. To develop such data and information as to the water supply, irrigated and irrigable areas, storage possibilities, etc., as would provide the basis for a program of future conservation and development within the two counties which might be recognized in any general plan for development of the water resources of the entire State that may be adopted.

2. To develop such data as to the present use of water as would be necessary to define all existing water rights from Pit River and its tributaries within the two counties.

Scope of Report.

This report includes certain basic data collected during the course of the investigation, together with other basic data obtained by prior and contemporaneous investigations. These data are contained principally in tables at the end of the report and cover miscellaneous stream flow and diversion measurements, water usage, irrigated acreage, irrigable acreage and crop production data. Basic stream flow records collected both prior to and during the investigation are available in Water Supply Papers Numbers 298, 391, 511, 531, 551, 571, 591, 611, 631, 651, 671, 691, 706 and 721 of the Water Resources Branch, U. S. Geological Survey. Analyses and summaries resulting from studies of basic data are presented in short tables and plates included at appropriate points in the text.

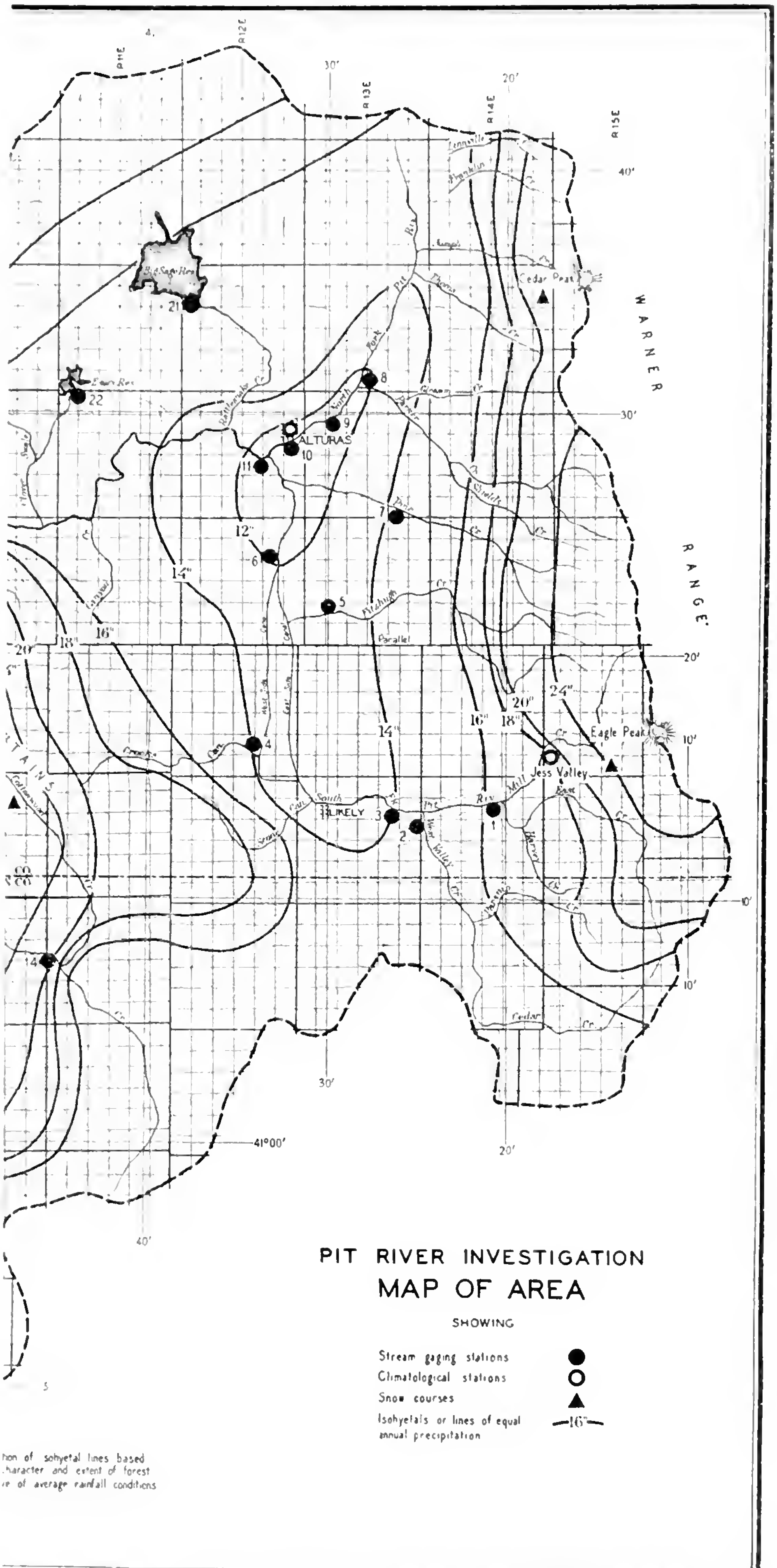
The report also contains detailed discussions of the physical features, climate, water supply, present and prospective uses of water in the area, and the value of administration of the stream system. Data and conclusions concerning certain additional storage possibilities, including the engineering and construction aspects of four apparently feasible projects, are discussed in the concluding chapter.

This report also includes an irrigation map of the entire upper Pit River watershed, entitled "Irrigation Map of Pit River Basin." This map was prepared from field surveys made by the Division during the course of the investigation, and shows the location and extent of irrigated and agricultural lands, streams, reservoirs, springs, ditches, dams, roads and towns upon a base compiled from U. S. Geological Survey and U. S. Forest Service maps. The map will be found in the pocket at the back of this report.

Physical and Climatological Features of the Basin.

The extent of the area in the upper Pit River watershed considered in this investigation, and the relative geographical location of the physical features of the basin, are shown on Plate I.

The territory involved is situated in the northeastern part of California, in the mountain plateau region east of the Sierra Nevadas. It covers an area of about 3000 square miles, with about 2000 square miles in Modoc County and 1000 square miles in Lassen County. It extends from the headwaters of the stream system along the western summits of the Warner Range on the east, westerly to the western boundaries of Modoc and Lassen counties, and from the poorly defined


PIT RIVER INVESTIGATION
MAP OF AREA
SHOWING
Stream gaging stations
Climatological stations
Snow courses
Isohyetals or lines of equal annual precipitation
16"
ALTURAS
LIKELY
Jess Valley
Eagle Peak
Cedar Peak
WARNER
RANGE
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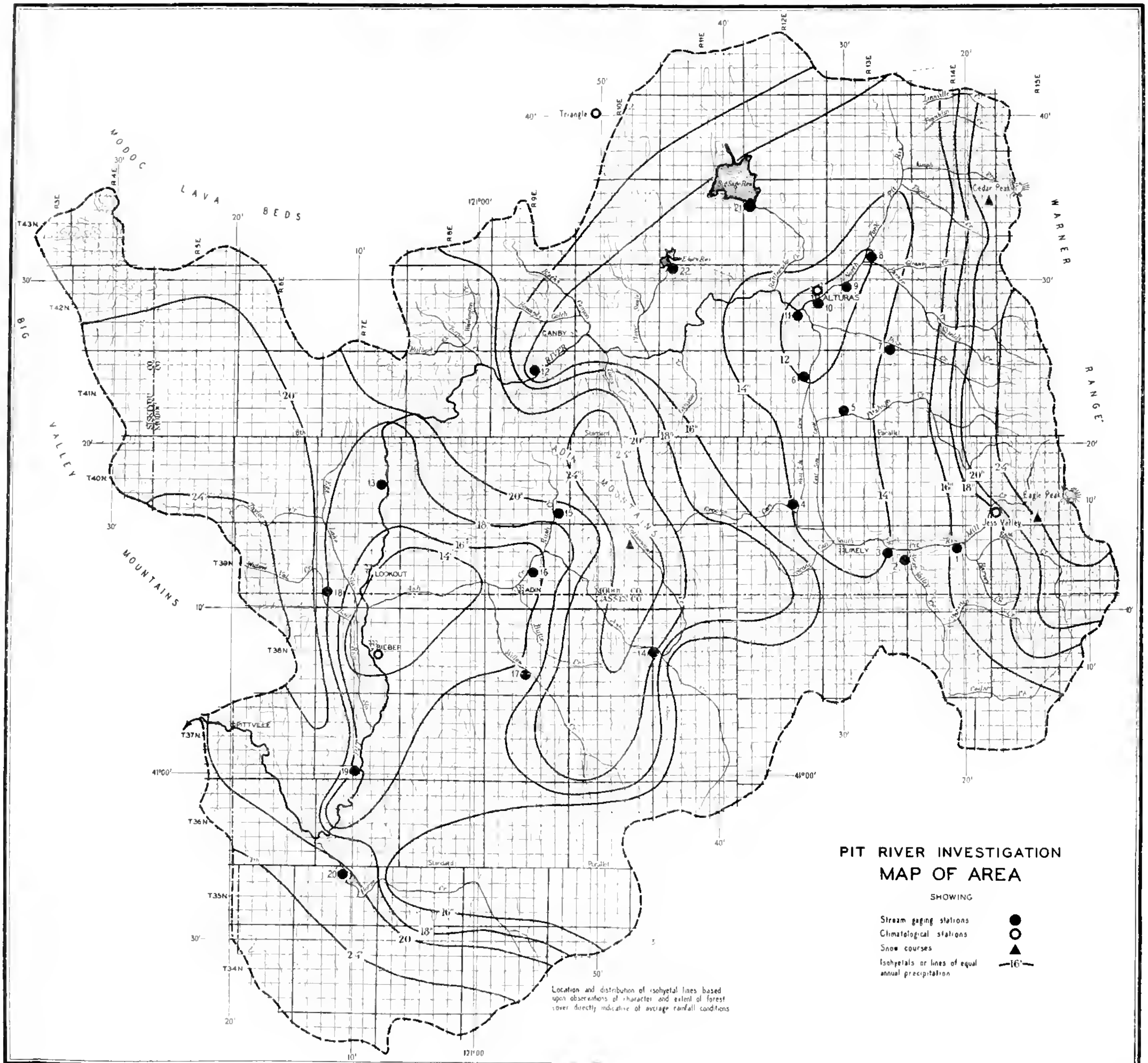
PIT RIVER INVESTIGATION
MAP OF AREA
SHOWING
Stream gaging stations
Climatological stations
Snow courses
Isohyetals or lines of equal annual precipitation
Location and distribution of isohyetal lines based upon observations of character and extent of forest cover directly indicative of average rainfall conditions
MODOC LAVA BEDS
BIG VALLEY MOUNTAINS
WARNER RANGE
ADIN MOUNTAINS
ALTURAS
CANBY
LOOKOUT
BIEBER
ADIN
LIKELY
Jess Valley
Cedar Peak
Eagle Peak
Triangle
MODOC CO.
LASSEN CO.
PITTVILLE
RIVER

divide across Devil's Garden and the Modoc Lava beds on the north to the Madeline, Ash Valley, and Horse Creek divides on the south.

The Goose Lake drainage basin, comprising an area of some 1100 square miles, was not included in the area under this investigation, though topographically within the Pit River drainage basin. Goose Lake is reported to have discharged into Pit River only twice since 1871; once in 1881 and again in 1898, during severe storms from the north. There are no surface indications that the waters of Goose Lake basin are tributary to Pit River, except by direct discharge over the lake rim. Since about 1910 there has been a progressive lowering of the water level until in 1926 the lake was entirely dry. Irrigation developments and storage projects on the tributaries may partially account for the continued low levels. However, early Federal army records show that during the 1840's the bed of Goose Lake was sufficiently dry to afford an army and emigrant road across it. Subsequent to 1926 the lake has remained at unusually low stages, being completely dry during 1929, 1930, and 1931.

Pit River drains the area under investigation, and, considered together with the Sacramento River which forms its outlet, bears the distinction of being one of three rivers which rise east of the Sierra Nevada and Cascade ranges and cut across the entire mountain belt to find an outlet in the Pacific Ocean. The main Pit River is formed by the junction of the North and South Forks immediately below Alturas. From the junction downstream the river flows generally westward through Hot Springs Valley, through a gorge in Adin Mountains, through Big Valley, through a gorge in Big Valley Mountains, through Fall River Valley, thence through the deep canyon gorge of the Cascades, finally joining the Sacramento River at a point about two and one-half miles above the town of Kennett.

The total length of channel of upper Pit River from the headwaters of the South Fork downstream through Jess, South Fork, Hot Springs and Big Valleys to the Lassen-Shasta county line, is about 130 miles. The channel is well defined throughout its length. The gradient of the stream is rather steep as it flows through the canyons but is relatively flat in the valleys. In these latter areas many sloughs break out from the main stream, and, after running for a distance in the same general direction, reunite with it lower down, thus forming the broad expanse of natural meadow lands found in the valleys

The topography, geology and climate of the area are characterized by the general features common to the Great Basin; namely semiarid, undulated plateaus interspersed with maintain ranges, and with lava rocks and ancient lake beds predominating.

Topography. The territory is topographically divided into six major areas, each of which, owing to the topographical divides and the regimen of the river or tributary draining the particular area, has its own problem as to water supply. These divisions are the North Fork, South Fork, Hot Springs Valley, Ash Creek, Big Valley and Horse Creek areas.

Geology. Geological evidence points to the fact that at one time most of the area under investigation was covered with water by a lake or sea of very great extent, the bottom of which was a nearly flat and

divide across Devil's Garden and the Modoc Lava beds on the north to the Madeline, Ash Valley, and Horse Creek divides on the south.

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Geology. Geological evidence points to the fact that at one time most of the area under investigation was covered with water by a lake or sea of very great extent, the bottom of which was a nearly flat and

level basin. Following periods of time saw the recession of this body of water from the Pit River area due to the relative raising of the bottom, and sometime during that process the basalt lava flows occurred. Subsequent to the lava flood the present topography was formed, and a series of lakes covered practically the entire area. These lakes were probably short lived, and the cutting down of their outlets drained them to the level of the valley floors found today. The processes of lake deposits and valley filling accounts for the sediments of undetermined depth found in the bottom lands of the valleys.

Soils. The soils of the area have been classified according to their relative topographical distribution; as river bottom soils, valley floor border soils, soils on rolling or terrace lands, and soils on range lands. In general these soils retain moisture well and produce good crops under irrigation.

Climate. The climate over the upper Pit River watershed is semi-arid. Low precipitation, a wide range of temperature variations and prevailing low humidity are the predominating features.

The average seasonal precipitation ranges from under 12 inches at Alturas to about 24 inches at the higher elevations. Approximately 75 per cent of the precipitation occurs during the wet season from October first to May first. About 65 per cent of that which falls during the wet season occurs in the form of snow. While a considerable amount of precipitation falls in the dry season, it is nevertheless necessary to supplement the natural moisture during this period with water applied through irrigation, for the successful production of crops.

The temperatures encountered in the area are those typical of the high plateau regions of California. The average growing season is about 100 days, considered as the interval between the last killing frost in the spring and the first killing frost in the fall. However, for the natural and predominant crops produced in the area the growing season is approximately 180 days.

Water Supply.

A tabulation of the estimated total run-off of the entire upper Pit River watershed and of the measured run-off passing out of the area is presented in Table 1.

A wide variation in the seasonal run-off for successive years is to be noted. The greatest extreme is between the first and last years of record, when the run-off was 260 and 30 per cent, respectively, of the mean.

The difference between the estimated run-off of the watershed and the total outflow from the area averages 134,000 acre-feet. This is the quantity of water consumed in irrigation plus the incidental losses by evaporation and transpiration of vegetation along the streams. The mean seasonal run-off passing out of the area for the period of record was 374,000 acre-feet, or about 75 per cent of the total water crop. Approximately 292,000 acre-feet, or 78 per cent of this surplus, occurred during the period from November first to April fifteenth. For the three-year period of the investigation 75,000 acre-feet, or about 34 per cent of the mean run-off, was surplus water; and 65,000 acre-feet, or 87 per cent of this surplus, occurred between November first and April fifteenth. This apparent surplus of water, however, is not

available for use in the watershed as a whole, owing to the topographical divides and to the regimen of the river heretofore noted.

TABLE 1

RUN-OFF OF PIT RIVER NEAR BIEBER

Season	Run-off in acre-feet		
	Estimated total seasonal	Measured seasonal outflow	Measured outflow Nov. 1 to April 15
1903-04	1,330,000	1,241,000	873,000
1904-05	392,000	303,000	264,000
1905-06	844,000	755,000	596,000
1906-07	1,220,000	1,129,000	815,000
1907-08	272,000	187,000	162,000
1913-14	827,000	594,000	558,000
1921-22	520,000	353,000	214,000
1922-23	236,000	95,100	87,400
1923-24	217,000	84,100	77,900
1924-25	310,000	151,000	134,000
1925-26	280,000	119,000	110,000
1928-29	247,000	91,000	69,500
1929-30	266,000	112,000	103,000
1930-31	150,000	25,800	24,300
Mean	508,000	374,000	292,000

The estimated mean seasonal run-off for the three years covered by the investigation was 220,000 acre-feet. The approximate distribution of this run-off to the major areas of the watershed is shown in Table 2.

TABLE 2

DISTRIBUTION OF RUN-OFF

Area	*Mean run-off in acre-feet for 3-year period 1929 to 1931*
North Fork	30,000
South Fork	75,000
Hot Springs Valley	40,000
Ash Creek	30,000
Big Valley	45,000
Total	220,000

The Horse Creek area, which is tributary to the main stream below the gaging station, produced a mean run-off of about 10,000 acre-feet for the same period.

The perennial springs forming the headwaters of the more important tributaries of the upper Pit River, are a reliable source of supply. These waters, however, are largely consumed for irrigation purposes along the tributaries and contribute little or no water to the main stream during the summer season. The major portion of the irrigated land in the watershed is therefore dependent upon the run-off from rains and melting snows. Except in subnormal seasons such as 1930–31, this latter supply is generally adequate to mature the meadow hay crop over the entire area, but is inadequate for pasture irrigation after haying.

To relieve the shortage of water some 53 reservoirs, with an aggregate capacity of about 140,000 acre-feet, have been constructed within

the watershed. The reservoirs range in capacity from 5 acre-feet to 77,000 acre-feet for Big Sage Reservoir, and are used principally to furnish water for stock and as supplemental irrigation supplies for lands irrigated from other sources.

Use of Water.

The waters of the upper Pit River watershed which are diverted within that area are used exclusively for irrigation and stock watering purposes, with the exception of a small hydroelectric power development on Pine Creek. This power plant has an installed capacity of 440 kilowatts, and supplies Alturas and Cedarville with electric power. It is located on the stream above all irrigation diversions, and, except for fluctuations in the flow caused by release of water from a small forebay, has no effect on the irrigation supply.

Meadow grass hay and pasturage, grown on the broad bottom areas adjacent to the streams, are the major crops produced in the watershed. These crops are irrigated by flooding, either from ditches or from the stream by means of dams obstructing the channel. About four irrigations between about April 15th and haying time are required for the successful production of these crops.

There are approximately 73,000 acres of irrigated land and some 221,000 acres of nonirrigated agricultural land in the upper Pit River watershed. The irrigated lands are mostly situated in the valleys along the main streams while the nonirrigated areas lie higher in elevation, or are remote from any readily available source of water supply. The extent of these latter lands that are susceptible of irrigation under present economic conditions can be determined only by considering the probable costs for the necessary irrigation works.

The measured consumptive use of water in 1931 varied in the several areas from a maximum of 4.2 acre-feet per acre for lands adequately watered from springs to 0.41 acre-foot per acre for the inadequately watered lands in Big Valley. In general the results indicate that the amount of water consumed in any area is largely dependent upon the adequacy of the supply. Under present water supply conditions the average consumptive use is approximately 1.55 acre-feet per acre.

The desirable net seasonal use is considered as the amount of water necessary to supply the total consumptive requirements during a normal irrigating period extending from April 15th to September 30th. Such amounts for the South Fork and Big Valley areas were estimated to be 1.71 and 2.45 acre-feet per acre, respectively. Approximately two-thirds of the seasonal use is required prior to haying, and the other one-third after haying.

Water for live stock is incidental to irrigation requirements during the irrigation season, but during the fall and winter seasons becomes an important consideration in the water requirements of the area. Stock water must be reasonably available to all pasture lands in order to fully utilize the feed.

Return water is an important factor in the irrigation supply of the upper Pit River lands. The return water from an upper area is often the only source of supply for an area downstream, and this condition of re-use occurs generally throughout the length of the main river and

its tributaries. The average amount of water returned from irrigated meadow lands ranges from 20% to 25% of the amount of water applied.

The administration of diversions on a number of streams in the area was carried on in conjunction with the investigation. Under the terms of the various agreements covering this work comprehensive schedules of distribution were instituted and supervised so as to make the most economical use of the available water. Each water user was afforded a series of satisfactory irrigations, and accurate data of the use of water were secured. By coordination of the many diversions along the streams, unnecessary waste was eliminated; thus conserving the water supply. The data collected in the course of this work are available as a basis for adjudications of water rights that may be undertaken in the future.

Proposed Storage Projects.

The areas presently irrigated include practically all of the lands that can be readily and economically developed with the available water supply under the present systems of irrigation; hence any material increase in irrigation development in the basin, either irrigation of new lands or the improvement of the water supply for the old lands, must come through the development of storage.

An analysis of the data at hand indicates that no one storage project can be developed suitable to conserve the water supply available within the basin, for the benefit of the area as a whole. Furthermore, from an economical standpoint, it does not appear feasible to develop any projects in the near future which contemplate the irrigation of any considerable amount of new acreage. Accordingly, storage developments discussed in this report are confined to projects mainly providing a supplemental water supply for lands now irrigated.

In the North Fork area, three possible reservoir sites were given consideration, but none of these appear feasible. Apparently the conservation of water in this area can be accomplished only through stream administration.

Four storage possibilities were investigated in the South Fork area, of which either the Jess Valley or the West Valley reservoir sites appear feasible for a supplemental irrigation supply for the lands presently irrigated in South Fork Valley. The Jess Valley site would afford supplemental water for 13,400 acres of presently irrigated lands, and a complete supply for 1300 acres of new lands. The West Valley site would supply the same acreage of irrigated land and 500 acres of new lands. Exclusive of the costs of the necessary reservoir sites, rights of way, water rights, etc., and apportioning the cost of construction to the present irrigated land only, the Jess Valley site could be developed at a cost to return an estimated increased net income of $1.49 per acre per year. The West Valley development would return an estimated increased net income of $1.51 or $1.66 per acre per year, dependent upon whether the South Fork Ditch or the Reversion of Cedar Creek plan is used. The costs of the Jess Valley and West Valley reservoir sites and the purchase of the water rights necessary to the plan for the Reversion of Cedar Creek, however, would materially alter the total costs of the project. These items and those involving dam foundation conditions must be investigated before a final conclusion as to the most favorable of the three plans can be reached.

The Hot Springs Valley area offers no feasible storage project, all the reservoir sites of any note having already been developed. The Big Sage project was analyzed to ascertain whether or not the watershed yields sufficient water to irrigate a materially larger area than is at present served from the reservoir. This analysis indicates what has been practically demonstrated since the reservoir was constructed; that the acreage served can not be materially increased.

The Allen Camp Reservoir is proposed for the benefit of the lands along Pit River in Big Valley. This site is situated on the main river about 12 miles above Lookout, and would afford a supplemental water supply for 12,000 acres of irrigated land and a complete supply for some 300 acres of new land. Exclusive of the costs of the reservoir site, rights of way and other easements, the project would return an estimated net increased income of $0.89 per acre per year. The costs of these items should be investigated, however, and further dam foundation exploration should be made, before commitment to the construction of the project.

For relief of conditions along Ash Creek in Big Valley, the Ash Valley Reservoir site appears favorable. This project would provide supplemental water for some 9000 acres of land irrigated from Ash Creek and about 800 acres of new land. Exclusive of the cost of the reservoir site, rights of way, etc., this project could be constructed at a cost to return an estimated increased net income of $3.11 per acre per year, considering only the present irrigated land. The cost of the reservoir site, however, would materially decrease such income, and must be considered in the final analysis.

Other reservoirs considered for the Ash Creek area were at the Ash Creek Canyon, Round Valley and Willow Creek sites. Of these only the Round Valley site merits further mention.

A reservoir could be constructed at Round Valley to yield from 9000 to 20,000 acre-feet per annum. A lateral of the State Highway passes through the site, however, so the project would involve from 5 to 7 miles of new highway construction. The estimated cost of the relocation of this lateral appears to be so high as to render the project impractical at this time.

In the Horse Creek area, data covering two reservoir sites were analyzed, one in Dixie Valley and the other in Little Valley. The Dixie Valley project would inundate more irrigated land than could be served with the available water supply, and is therefore infeasible. A reservoir in Little Valley would apparently supply a safe annual yield of 5000 acre-feet, but since there are no agricultural lands within the territory covered by the investigation which are susceptible of irrigation from this source, no cost estimates were made.

Conclusions.

(1) There are approximately 294,000 acres of agricultural land in the upper Pit River watershed, of which about 73,000 acres are now irrigated. The adequate irrigation of the present lands and the 221,000 acres of dry lands would require the entire water crop of the drainage basin.

(2) The major portion of the run-off of the watershed is not physically available to the agricultural lands as a whole, and no one storage project can be developed to serve the entire area.

(3) The only conservation projects of magnitude which appear presently feasible are for developing sufficient water to round out the irrigation requirements of lands now irrigated in South Fork and Big Valleys.

(4) Jess Valley and West Valley offer alternative reservoirs for the South Fork area. Furthermore, there are two alternative plans for development of the West Valley Reservoir. Dependent upon the reservoir site and plan selected, sufficient water can be developed to round out the irrigation requirements on some 13,400 acres of presently irrigated land, and provide for from 500 to 1300 acres of new land.

(5) The Allen Camp Reservoir project is apparently feasible for supplying some 13,000 acre-feet of additional water for 12,000 acres of presently irrigated lands, and 300 acres of new lands, in Big Valley.

(6) Development of the Ash Valley Reservoir to a capacity of 15,000 acre-feet is apparently feasible. This project would yield sufficient water to round out the irrigation supply for 9000 acres of developed land, and give a full supply for 800 acres of new land in the Ash Creek area.

(7) There are apparently no feasible storage projects in the North Fork area. In the Hot Springs Valley area, the Big Sage Reservoir and numerous smaller projects have already developed the favorable storage sites. Improvement in water supply conditions and manner of use on the streams in these areas can be accomplished only through stream administration.

(8) Stream administration is an important means of conserving the water supply of the stream system, by the prevention of unnecessary waste. The basic data for adjudications or permanent water right agreements as foundations for stream administration were developed in the course of the investigation, and are contained in this report.

(9) The average consumptive use of water for irrigation over the entire area under prevailing conditions is about 1.55 acre-feet per acre. The estimated average desirable use is about 2.25 acre-feet per acre.

CHAPTER II

PHYSICAL AND CLIMATOLOGICAL FEATURES OF THE BASIN

PHYSICAL FEATURES

Topographical Divisions.

The territory is topographically divided into six major divisions; namely, the North Fork, South Fork, Hot Springs Valley, Big Valley, Ash Creek, and Horse Creek areas. The locations of these areas are shown on Plate II.

The problems as to water supply and use of water in the various basins are largely unrelated, owing to the topographical divides and to the regimen of the river. Each of the basins is considered separately later in this report.

Relative Elevations.

The elevation above sea level of the bed of Pit River at the Lassen-Shasta county line is about 3250 feet; at the outlet of Big Valley 4115 feet; at Alturas 4345 feet; at Likely 4390 feet; and at Jess Valley outlet 5050 feet.

The average elevation above sea level of the floor of Big Valley is approximately 4150 feet; of Hot Springs Valley 4300 feet; of South Fork Valley 4365 feet; and of Jess Valley 5100 feet.

The elevation of the highest point in the watershed, Eagle Peak, is approximately 9940 feet above sea level. The elevation of the broad undulating plateau of the Devil's Garden is approximately 5100 feet above sea level.

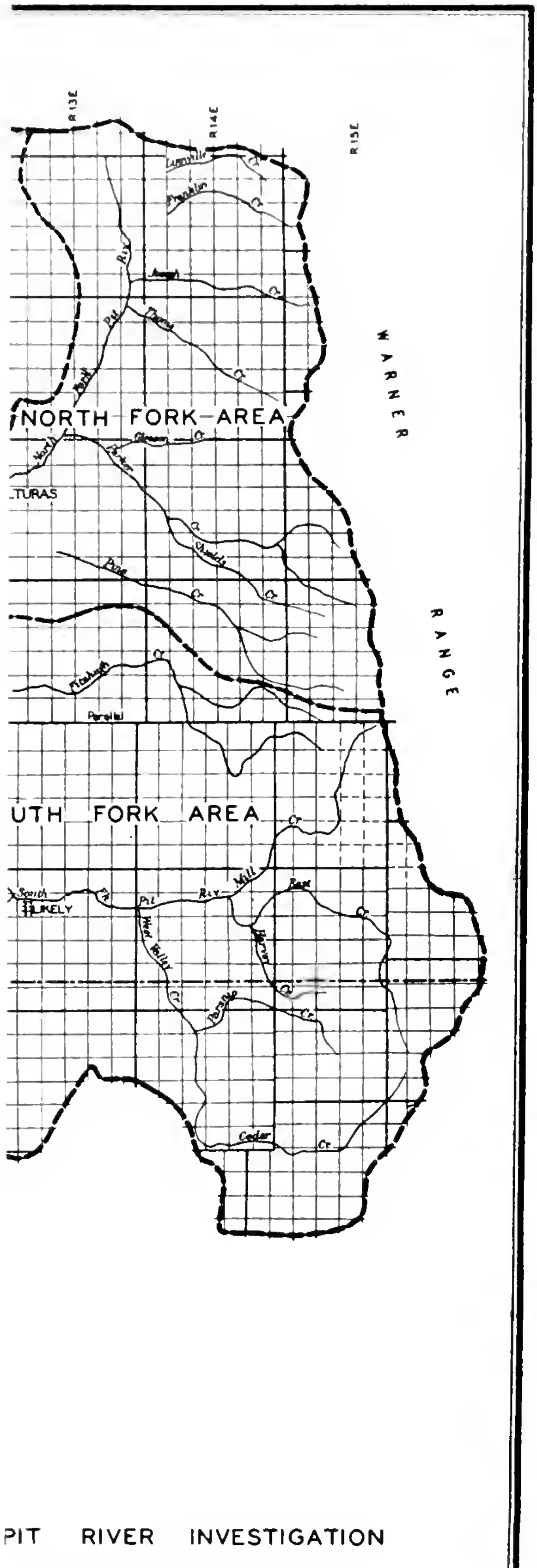
Geology.

The upper Pit River area is situated on the western fringe of the Great Basin. Its climate, topography and geology are characterized by the general features common to that area; namely, semiarid, undulated plateaus interspersed with mountain ranges, and with lava rocks and ancient lake beds predominating.

The major portion of the upper Pit River area is not covered by any existing geological report. Numerous reports covering adjacent areas on all sides are available, however, and one report, "Basin Range Structure and Stratigraphy of the Warner Range in Northeastern California" by Richard Joel Russell (Bulletin of the Department of Geological Sciences, University of California, Volume 17, Number 11), covers the eastern portion of the Pit River watershed by describing the western slopes of the Warner Range divide, and contains substantial reference to the Devils Garden area. Another report by the same author entitled "Landslide Lakes of the Northwestern Great Basin" (University of California Publications in Geography, Volume 2, Number 7, Pages 231 to 254), covers in exhaustive detail the formation of Clear Lake, Pine Creek Basin, Jess Valley, and other features in that vicinity.

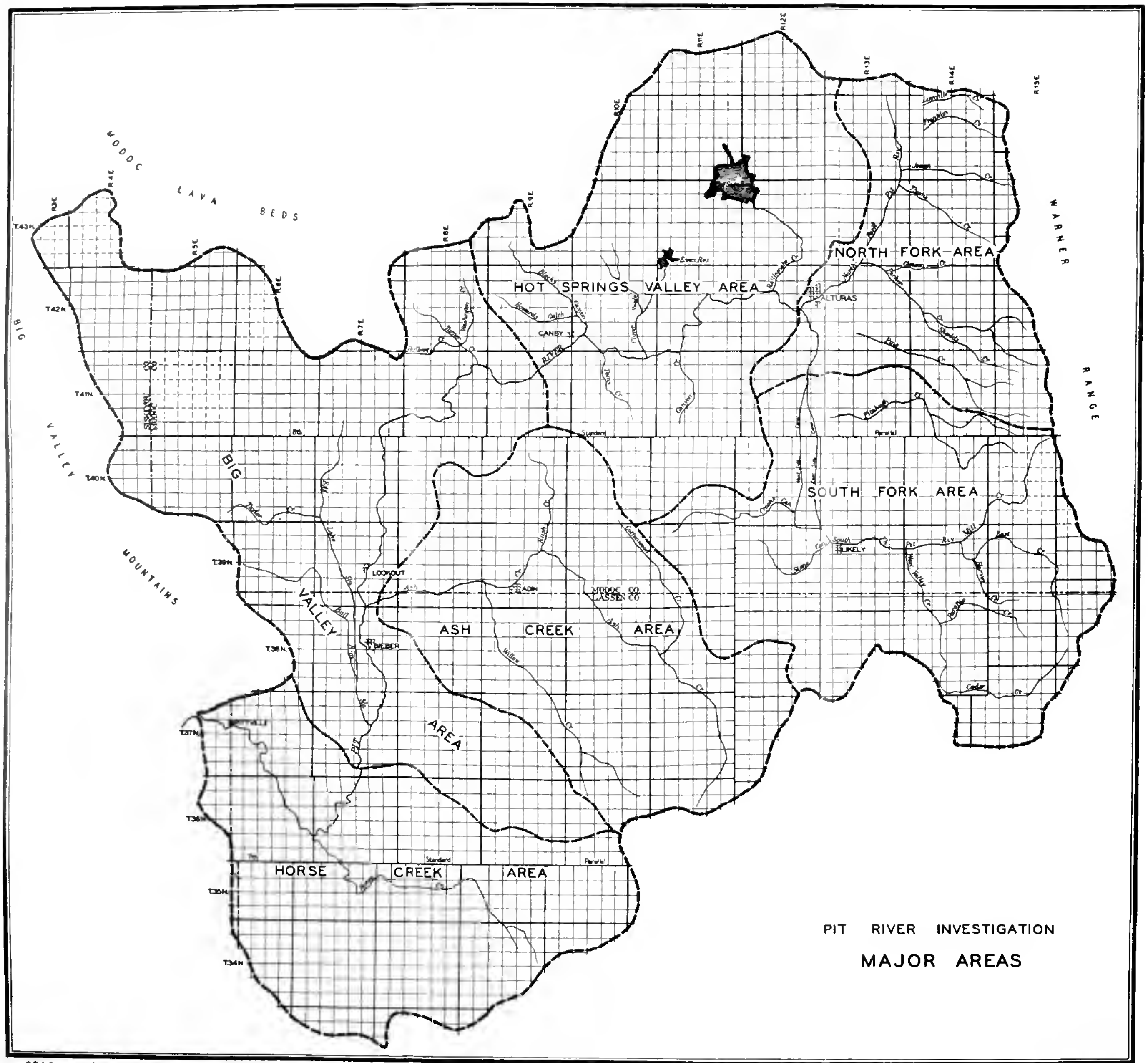
The general geology of the upper Pit River Basin is as follows:

The Warner Range of mountains is an upthrown and tilted block of Cedarville andestitic accumulations at least 7500 feet thick and



PIT RIVER INVESTIGATION

MAJOR AREAS



PIT RIVER INVESTIGATION

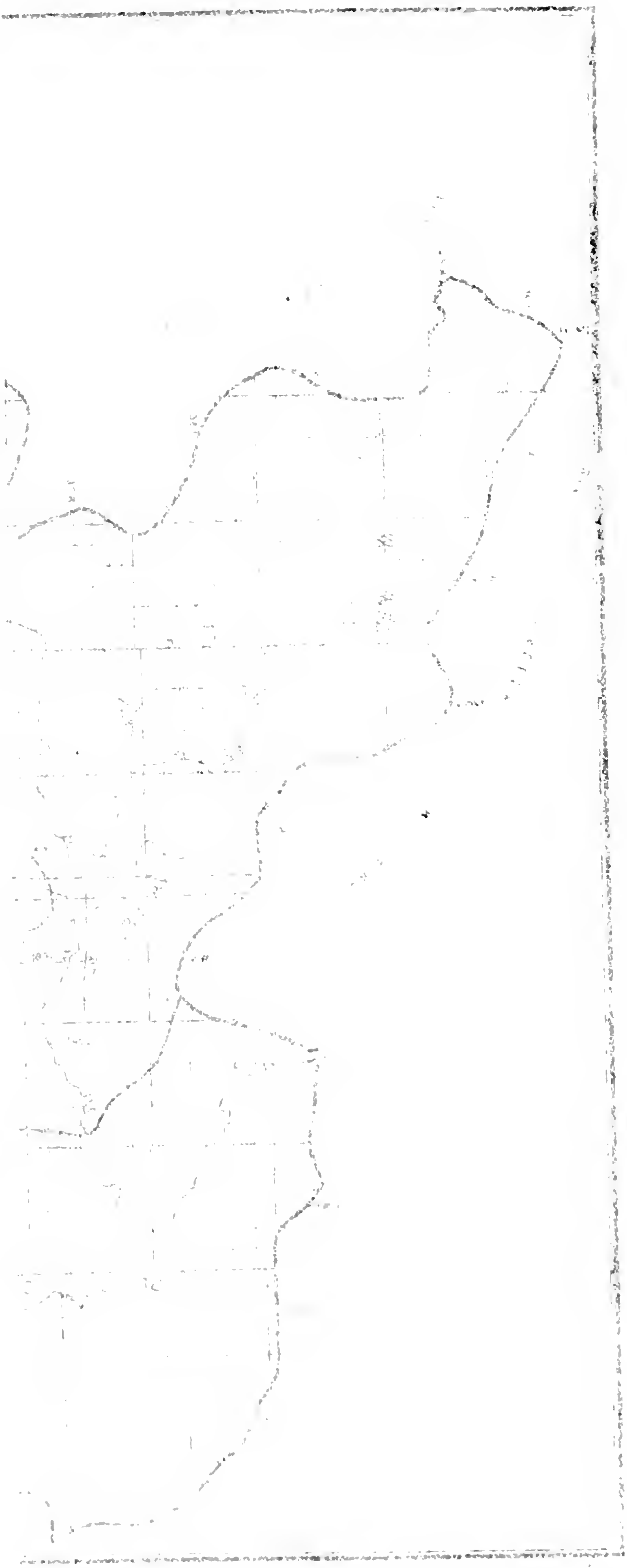
MAJOR AREAS

essentially concordant from base to top, with a thin capping of Warner basalt. The pocket valleys on the western slopes such as Jess Valley, West Valley and others, have been formed by the differential uplift on their west sides along fault zones extending north and south. These pockets formed lakes until the outlets eroded to such an extent as to drain them to the level of the predeposited alluvium, as they are now found. The lake which formerly occupied Jess Valley is considered to have been formed by a landslide at the outlet of the valley.

Flanking the western dip of the Warner Range is a graben, or downthrust block, of varying width extending from far into Oregon on the north, southward through Goose Lake Valley, North Fork Valley, and South Fork Valley to as far south as the Madeline Plains. This graben accounts for the existence of the South Fork Valley. The fault zone west of Likely broadens very considerably to include the complicated structures encountered in Hot Springs Valley and southward toward South Fork Mountain. Intricate branches of the faulting system account for the existence of the hot springs, table-top hills, plateaus and depressed valleys characteristic of that locality. The escarpments disclose a formation consisting of water-laid tuffaceous sediments with overlying basaltic flow caps.

North of Hot Springs Valley and west of Goose Lake and North Fork Valleys is the Devil's Garden; a broad expansive undulating plateau covering nearly 2000 square miles, and extending northward into southern Oregon. The south and east edges of the Garden are steep and precipitous escarpments 500 to 1000 feet deep to the floors of the valleys. The formation of the Garden, which is laid bare on the escarpment, consists of a relatively level capping of Warner basalt over an equally level sedimentary bed. Because of the wide spread continuity of the basalt floor of the Garden, geologists conclude that its elevation has been relatively stable while the surrounding areas have been thrust upward or depressed, as the case may be.

Because of the existence of sediments and detrital material underlying basalt flow it would appear that the entire upper Pit River area was once covered by a sea or lake of great extent, the bottom of which was a nearly flat and level basin. In his report upon the "Geology of the Lassen Peak District" (Eighth Annual Report of U. S. Geological Survey, Part 1, Page 413), Mr. J. S. Dillar, in describing the evidences of shore lines along the western slopes of the north Sierra Nevadas, says "but there can be no doubt that the ancient coast extended northeasterly around the northern end of what is now the Sierra Nevada range towards the headwaters of Pit River, and that during the Chico epoch the Lassen Peak district lay almost wholly within Lassen Strait, which separated the island of northwestern California from the continental land to which the Sierra country belonged." Further corroboration of the existence of a body of water over the area prior to the great basalt lava flood is contained in this quotation from Russell (Warner Range Report previously cited): "An extensive lake deposit immediately underlies the basalt in the eastern part of the Gardens and continues southward at least as far as Likely. Fragmental fish bones occur as fossils in exposures along Rattlesnake Canyon north of Alturas. Northwest of Canby, leaf impressions are found in similar beds."



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The periods of time following the Chico epoch saw the recession of the sea from the Pit River area by reason of relative raising of the bottom of this great bay. Sometime during that process the wide spreading basalt lava flows occurred, flowing apparently like water over the ancient lake bottoms, leaving an essentially level platform, of which the Devil's Garden is a large remnant.

The Adin Mountain formations are not specifically described in any available report. It is apparent that this range of mountains has been formed by the accumulations of extensive andesitic lavas which erupted from fissures parallel with the northwest-southeast axis of the range. Tectonic activities have deformed the original underlying sedimentary beds. These sedimentary beds are exposed to view at numerous places along the Pit River Canyon between Canby and Lookout, particularly in the vicinity of Stonecoal Valley. Outcroppings reveal white and yellow shales interlayered with carboniferous shales. Most of the valleys and depressions in the Adin Mountains have terraced floor characteristics. These terraces are usually composed of tuffaceous sediments or aglomerate overlain with gravelly alluvium.

The area in the northern part of the basin west of the Devil's Garden, known as the "Modoc Lava Beds," is a broad, rough, undulating area of lava flow in its most contorted form. The description of this area can best be made by again quoting from Russell's Warner Range report: "The Warner basalts present a surface characterized by topography quite unlike that of the recent Modoc basalts of the Modoc Lava Beds. This is recognized by the people living in the area who restrict the term 'Gardens' to the plateau of Warner basalt west of Goose Lake but who use the terms 'Lava Beds,' 'Burned Lava Country' or 'Lava Fields' for the continuation of the same plateau surface covered by the more recent effusives. The surface of the Gardens is relatively smooth and subdued. The Lava Bed surface is exceedingly irregular, large portions of it being so rough that they can not be crossed on horseback. Caves are frequent in the Lava Beds but absent from the Gardens and other areas of Warner basalt. The Lava Bed caves radiate out from Glass Mountain like spokes from the hub of a wheel. Some of the individual caves have been explored and mapped for distances as great as 16,000 feet. These caves were the stronghold of the Indians at the time of the Modoc War. At places the roofs have collapsed leaving holes commonly known as 'wells' or 'pipes.' Between such openings ice caves are not infrequent. Several 'natural bridges' remain standing across long caves with almost completely collapsed roofs. The surface irregularity of the Modoc basalt is so great that we are forced to the idea of very recent origin * * * certainly within the last few centuries."

West of the Modoc Lava Beds are a series of barren cinder cones, indicating recent volcanic activities. The promitories in that vicinity are dominated by the Glass Mountain ridge and the summits of the rim of the extinct crater in which Medicine Lake is located.

Big Valley Mountains, on the west side of the upper Pit River area, are a long, uniformly formed, dome-like ridge, composed of lava extrusions. Probably the material erupted from one or a series of fissures parallel with the crest of the mountain ridge. The main Pit River has traversed this range at its southern end through a deeply eroded

canyon. Tectonic disturbances and consequent faulting no doubt account for the structural weakness affording the crossing for the stream.

The mountainous area south of Big Valley and the Adin Mountains, which extends westward from South Fork Mountain to the Lassen-Shasta county line, is a mass of lava rock accumulations at a prevailing high elevation. The area is covered with numerous broad valleys or basins. In most instances the bottoms of these basins contain terraces and table lands underlain by tuffaceous sediments. The exposed lavas on the flanks of the mountain ridges indicate that the overbearing lava material has erupted from an intricate system of fissures and vents.

With all the evidence available, only a portion of which is indicated above, it would appear that prior to the basalt lava flood most of the area now considered in the upper Pit River watershed was covered with water as an inland lake or an arm of a great sea. Subsequent to the period of formation of the present topography, evidences indicate that a series of lakes existed, covering practically the entire area. This condition would have been the natural result of the damming-off of the normal drainage toward the west to the sea, by the Adin Mountain chain and the Big Valley Mountains. The steplike arrangement of the terraces and tablelands bordering the valleys show the extent of these lakes, and beach lines show their depths. Certain evidence pointed to in the following quotation indicates that the lake covering the present South Fork and Hot Springs Valley was connected to the quaternary lake covering the headwaters of the Klamath River. Quoting Mr. J. S. Dillar (U. S. G. S. Mineral Resources, 1886, page 588), "similar infusorial deposits" are found "on Pit River and lower courses of the Klamath. They occur * * * in the beds of extinct lakes."

The lakes were probably relatively short lived and the cutting down of the outlets drained them to the level of the valley floors found today. Through the combined processes of lake deposits and valley filling, the sediments in the bottom lands along the valleys have reached undetermined depths. The existence of organic material in the upper strata of the valley sediments indicates that the final layers were deposited in shallow water, which was possible only after the outlets of the lakes had been cut down to approximately the levels of the present valley floors.

Forest Cover.

Quoting from the Report on Pit River Basin by E. G. Hopson and O. W. Peterson, dated April, 1915: "Climatic conditions and especially precipitation are the chief factors in determining the extent and character or type of natural forest cover * * *. While soil and light are important requisites, tree growth is dependent to a greater degree upon a fixed minimum average annual precipitation than upon any other single factor. In general, where the annual precipitation is less than 20 inches, tree growth is scanty and composed of dwarfed species which have little commercial value. An annual precipitation of over 20 inches generally results in a commercial forest cover * * *. So intimate is the relation between precipitation and tree growth, however, that with information at hand regarding the precipitation in any given region, the character of the forest may be determined with a fair degree of accuracy. Conversely the amount and character of forest cover

serves as an indication of the amount of precipitation where other records are lacking."

In the western portion of the upper Pit River watershed, on the Big Valley Mountains, the annual precipitation averages slightly better than 20 inches. Belts of similar amounts of precipitation are found over the Adin Mountains. On the east and north exposures, and on the upper elevations, the forest cover on the Big Valley and Adin Mountains consists of a mixture of yellow pine, white fir, and incense cedar. The foothill table lands and lower slopes of these mountains are unvariably sparsely covered with juniper.

East of the Adin Mountains the annual supply of moisture decreases, which condition is directly reflected in the character and composition of the forest cover. On the large areas of the poorer rocky soils situated between 4200 and 5000 feet in elevation, particularly on the Devil's Garden and Rocky Prairie, the juniper type has taken possession because of its ability to withstand drought. On the lower tablelands and terraces slightly above the valley bottom lands, there is to be found only widely separated clumps of juniper, with sage brush covered ground intervening.

East of Alturas, on the slopes of the Warner Range, the precipitation increases with the resulting change from open prairie lands near Alturas to heavy timber on the upper slopes. Quoting in this regard from the above mentioned report:

"When the Warner Mountains are reached precipitation again increases with elevation and we find the same forest law governing the composition and density of the stand. In ascending this range a belt of juniper is first encountered, then pure yellow pine on south and west slopes. Still higher-up between 5500 and 7500 feet elevation the heaviest stands occur. These contain varying proportions of white fir and incense cedar, in addition to the yellow pine, and are found at their best on north and east slopes. Between 7500 and 9000 feet elevation the effect of exposure and altitude is again felt and the forest reverts to a mixture of rather unimportant abnormally formed trees, or the mountains are so rocky that there is no true growth."

Plate I in this report can be used to give a fair measure of the character and density of the forest cover. The isohyetal lines shown on that map of the upper Pit River watershed may also be interpreted to give the forest cover in accordance with the following table:

TABLE 3

RELATION OF FOREST COVER TO PRECIPITATION

Areas lying between Isohyetals of	*Composition of forest cover*	*Density of forest cover*
12" to 14"	Occasional Juniper	Nil
14" to 16"	Sparse to Heavy Juniper	Nil
16" to 18"	Heavy Juniper and Light Yellow Pine	5,000 to 10,000 b.f. per acre
18" to 20"	Yellow Pine	10,000 to 20,000 b.f. per acre
20" to 24"	Yellow Pine, White Fir and Incense Cedar	20,000 or more b.f. per acre
24" or over	Red Fir, Tamarac, etc.	20,000 or less b.f. per acre

Soils.

The scope of this investigation does not include a detailed description and classification of the various soil types in the area. Only a general differentiation and description is contained in the following

discussion, from the point of view of the relative agricultural values of the types of soil. As heretofore referred to, during 1931 a complete soil survey of the upper Pit River watershed and the Goose Lake and Surprise Valley areas was made by the University of California and the U. S. Department of Agriculture, Bureau of Soils. The final report of that survey will contain the detailed information concerning each of the various soils, together with a full map of the area showing their location. Heretofore, a report entitled "Soil Survey of the Big Valley, California," by the U. S. Department of Agriculture, Bureau of Soils, cooperating with the University of California, has been published. The area covered includes Big Valley alone. The later 1931 survey includes Round Valley near Adin as well as Hot Springs Valley and the North and South Forks of Pit River.

Certain preliminary information has been made available to the Division of Water Resources regarding the location of the soils and their relative agricultural values. Based upon that information the agricultural lands in the upper Pit River watershed have been platted as shown on the Irrigation Map.

In this report arable lands are considered as agricultural lands, without regard to whether or not they are physically or economically susceptible of irrigation. As indicated in later chapters the bulk of the nonirrigated agricultural lands lie above the flood-planes of the streams, and to irrigate those lands long and tortuous ditches must be constructed, which would be quite expensive.

In the following general descriptions of the soils in the upper Pit River watershed, they are classed according to their relative topographical distribution, as follows: river bottom soils, valley floor border soils, soils on rolling or terrace lands, and soils on range lands. In each class the depth of the soils and the character of the substratum are the predominant factors in determining their usefulness.

River Bottom Soils. The soils lying on lands below the flat flood-planes of the streams consist chiefly of heavy loams with clay or adobe characteristics. Along Pit River in Big Valley, Hot Springs Valley, and South Fork Valley these soils are generally comparatively deep, and have been developed on compact substratum. This group includes muck and peat, which is found in the Jess Valley Swamp, and mucky loam, which is found in the South Fork Valley. These latter soils have very high percentages of fibrous undecayed organic matter in the upper strata and decomposed organic matter in the deeper strata. On meadows which are continuously flooded the fact that the soil may be shallow has little effect upon the crop, because the prevailing high water table prevents the growth of all deep rooted plants.

Valley Floor Border Soils. These soils lie on the gently sloping lands situated slightly above the flood-planes of the streams, which lands include alluvial fans. In general the lands bordering the irrigated meadows are shallow, consisting of loams and clay loams developed on compact substream. Where these border lands are irrigated by means of ditch systems, fair stands of meadow grass are obtained, but the water holding capacity of the soils is comparatively low and they are prone to quickly dry out. The soils on the alluvial fans such as have been formed in Jess Valley from Mill and East Creeks consist

chiefly of gravelly and sandy loams. They are very light and permeable, and require frequent irrigations to prevent parching of the grasses. In general the alluvial fan soils are developed over uneven substratum and there are large areas where the substratum is close to the surface and is either bed-rock or very compact and tight soil.

Soils on Rolling and Terrace Lands. The soils on the rolling lands, when free of surface rocks and stones, are in general very satisfactory for farming. They consist of gravelly and sandy loams, with good water holding capacity providing they are comparatively deep. Where irrigated by high-line ditch systems these deeper soils produce excellent crops. Where the soils are shallow, however, cultivation has not proved practicable. The largest areas of irrigated alfalfa lie on the rolling lands situated above the floors of South Fork and Hot Springs valleys.

The surface soils on the undulated terrace lands are of relatively high agricultural value, but are generally shallow and underlain by compact substratum. Irrigation of these terrace lands has not been extensive owing to the difficulty of elevating the water supplies. A few pumps are found along Pit River in Hot Springs Valley which are used to irrigate approximately 280 acres of terrace alfalfa land. In general these soils dry out very rapidly.

Soils on Range Lands. The surface soils covering the major part of the plateau and mountain areas consist of a heavy sandy loam or clay loam, and are generally strewn with volcanic rock boulders. They have developed over bed rock or other compact substratum. Between the surface stones and boulders the exposed soils yield a healthy stand of bunch grass and sage brush. These soils retain moisture fairly well, differing from the terrace lands on which vegetation is somewhat stunted due partly to early season drying out of the soil. The heavier stands of timber are found on the deep phases of these range land soils. The shallow soils of this group cause the scab-lands, where soil over bedrock or consolidated substratum does not exceed 12 inches in depth. Lands containing this group produce fair crops when cleared of rocks and brush, but have not been shown as agricultural lands on the Irrigation Map because they are not readily arable.

CLIMATE

In common with the climate prevailing generally over the Great Basin, the upper Pit River watershed is semiarid. Low precipitation, an abundance of sunshine, a wide range of temperature variations, and prevailing low humidity are the salient features of the weather.

Prior Records Available.

Climatological data for Alturas have been recorded by the United States Weather Bureau, and later by the United States Forest Service. The records cover the seasonal years from 1904 to 1920 and from 1925 to date. This was the only station maintained within the entire upper Pit River watershed prior to this investigation. Records are available for a number of stations within a radius of 100 miles of the Pit River area; at Cedarville and Fort Bidwell in Surprise Valley, at Burney and Fall River Mills in Shasta County, and at Klamath Falls and Lakeview in Oregon. Due to local topographical features effecting the climate in their immediate vicinity, however, those records are not

considered as representative of the conditions prevailing throughout the area under investigation.

Climatological Stations Established.

From a study of the prior existing records it was realized that the topographic features of the upper Pit River Basin have a marked effect upon the climate in the different sections of the area. The existing records were found to be inadequate to correlate the variations of run-off, and observations of wide variations in the rates of plant growth indicated wide ranges of temperature. Three new stations were established within the area—at Jess Valley, Triangle Ranch, and Bieber—in addition to the Alturas station, which was maintained during the investigation. These four stations were equipped and maintained in connection with the state-wide snow survey program conducted by the Division of Water Resources.

The stations were equipped with standard eight-inch rain gages, self-registering maximum and minimum thermometers, and snow collection platforms. In addition to such equipment, a recording rain gage was installed at the Alturas station for the purpose of obtaining a record of extreme intensities of rainfall which may occur during prevalent summer thunder showers; however, during the period of the investigation no such storms occurred at the station.

The locations of the stations are shown on Plate 1.

Jess Valley Station. This station is located at the Walter Cantrall Ranch on the northeast side of Jess Valley, at an elevation of 5400 feet. Its location is representative of the upper lying agricultural lands on the western flanks of the Warner Range, in the lower edge of yellow pine timber belt.

Alturas Station. This station is located in Alturas on the County Court House block, at an elevation of 4360 feet. (Corrected from 4460 feet as result of the 1931 U. S. Coast and Geodetic Survey levels.) Its location is representative of the large agricultural areas of the North Fork, South Fork, and Hot Springs valleys.

Triangle Ranch Station. This station is located on the northern rim of the upper Pit River watershed in the center of Devil's Garden, at an elevation of 5000 feet. Its location represents a vast flat plateau area at the southern edge of the yellow pine belt, which extends across the north central portion of Modoc County.

Bieber Station. This station is located in the town of Bieber, in the center of the floor of Big Valley, at an elevation of 4200 feet. Its location is representative of the lower portion of the upper Pit River watershed.

Precipitation.

Precipitation over the upper Pit River area, in common with that throughout the State, is characterized by a wet season and a dry season. The wet season extends from about October first to about May first, and the remainder of the year constitutes the dry season. Due to this characteristic it is necessary to use the seasonal year extending from October first to September thirtieth, inclusive, for purposes of comparison, rather than the calendar year.

On account of its proximity to the Great Basin the storms occurring over the Pit River region have a "spotted" distribution. It is not uncommon to witness a consecutive series of storms giving abnormal precipitation along some narrow path, while a few miles away subnormal conditions exist during the same period.

The mean seasonal precipitation at Alturas is approximately 12 inches, of which about 75 per cent falls during the wet season. Due to the common occurrence of thunder showers the percentage of the total seasonal precipitation which falls during the dry season is relatively high in comparison with that in the large central valley areas of the State; nevertheless, for the successful production of the crops grown in the region it is necessary to supplement the natural moisture with water applied through irrigation.

Precipitation in the form of snow generally occurs during the period from December to March, with occasional flurries in April. Approximately 65 per cent of the total precipitation in the winter and spring months occurs as snow.

The average annual distribution of precipitation over the upper Pit River watershed is shown in Plate I. The lines shown on this plate are lines of equal annual rainfall. The distribution of these isohyetals was determined from two sources; the records at the four rainfall stations, and the data available showing the composition and density of the forest cover.

The effect of elevation is clearly marked upon the precipitation in the region. With the prevailing southwest approach of storms, the abrupt southern and western slopes of the Big Valley, Adin and Warner Ranges cause the heaviest precipitation. The low lying plateau areas and valleys east and northeast of the mountain ranges suffer from a deficiency of precipitation to such an extent as to make those areas naturally unproductive of anything but scattered juniper trees and stunted sage brush.

There is no direct relation between precipitation and run-off during the winter and early spring months. This is due to the freezing temperatures and to the fact that the major portion of the precipitation occurs in the form of snow. The usual February and March thaws cause aggravated flood run-off conditions if a rain occurs simultaneously. During April and May the precipitation in the form of rain produces immediate run-off in the streams.

A summary of the records of precipitation at Alturas is submitted in Table 4. A comparison of the monthly and seasonal precipitation at the four stations maintained during the investigation is shown in Table 5.

TABLE 4

PRECIPITATION AT ALTURAS ELEVATION 4360 FEET

Monthly, Seasonal and Average Amounts in Inches, 1904-1931

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Season
1904-05	1.00	0.55	1.86	0.97	1.31	2.96	0.51	1.11	0.78	0.00	0.00	0.27	11.62
1905-06	.22	.94	.52	3.87	1.08	3.20	.66	2.46	.96	.01	.05	.60	11.57
1906-07	.27	.97	3.52	1.35	2.87	4.13	.39	1.21	1.68	.55	.27	1.09	18.30
1907-08	1.90	1.11	1.82	1.04	.16	.26	.35	1.31	.42	.21	.19	1.10	9.87
1908-09	1.42	.66	.67	4.47	1.58	.53	.66	.73	.49	.10	.26	.67	12.24
1909-10	1.40	1.94	1.78	1.27	1.28	.43	.26	.63	.24	2.29	.00	1.91	13.13
1910-11	.01	2.59	2.25	3.16	.59	.68	.97	.59	1.01	.97	.00	.58	13.40
1911-12	.37	.62	.59	.99	.38	1.53	2.71	1.07	.90	.64	.53	.87	11.20
1912-13	.24	.59	.58	1.92	.16	1.43	2.08	.68	2.20	3.00	.87	.22	13.97
1913-14	.10	1.59	2.52	2.28	.48	.31	1.51	.64	1.09	.14	.04	.07	10.74
1914-15	1.51	.14	.40	1.30	1.94	.55	1.31	1.59	.06	.78	1.42	.13	11.13
1915-16	.19	1.46	.55	4.35	.67	.61	.75	2.57	.18	.48	.62	.16	12.62
1916-17	2.17	.63	2.00	1.36	3.33	1.69	1.35	.98	.31	.02	.62	.28	14.74
1917-18	.00	1.01	.38	.83	1.16	2.48	.30	.67	.02	.00	.03	.61	7.19
1918-19	1.04	.92	.75	.57	3.47	1.05	.67	.02	.00	.00	.03	1.92	10.44
1919-20	.63	.47	3.00	.29	.46	1.15	1.59	.42	.90	.40	1.19	.18	10.68
1925-26	1.15	1.16	1.00	.18	1.63	*.13	1.50	.60	*.00	*.09	*.09	*.15	7.98
1926-27	.53	2.71	1.08	.97	1.73	1.95	1.05	.40	.51	.14	.17	.89	12.13
1927-28	1.31	3.06	.10	.99	.61	2.83	.44	.18	.75	.00	.00	.20	10.80
1928-29	.39	1.45	.39	.83	.12	.75	2.57	.00	1.18	.00	.01	.01	8.00
1929-30	.54	.00	1.60	2.24	1.77	1.14	.64	.90	.10	.00	.03	1.00	9.96
1930-31	1.15	.57	.23	.67	.67	1.03	.46	.06	.57	.00	.04	.64	6.05
Means	.84	1.16	1.27	1.65	1.26	1.40	1.03	.87	.65	.44	.28	.62	11.43

NOTE. Records by United States Weather Bureau, October, 1904, to December, 1919; by United States Forest Service, October, 1925, to September, 1929; and by State Division of Water Resources, October, 1929, to September, 1931.

*Estimated from Cedarville Station.

TABLE 5

COMPARISON OF PRECIPITATION AT JESS VALLEY, ALTURAS, TRIANGLE AND BIEBER, 1929-1931

Monthly and Seasonal Amounts in Inches

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Season
Jess Valley													
1929-30	---	---	2.11	2.72	2.01	1.29	1.01	1.57	.13	.02	.05	1.91	13.15
1930-31	.90	1.19	.13	.80	.88	1.64	.39	1.01	.61	.00	.28	.16	8.29
Alturas													
1929-30	.54	.00	1.60	2.21	1.77	1.14	.64	.90	.10	T	.03	1.00	9.96
1930-31	1.15	.57	.83	.67	.67	1.03	.46	.06	.57	.00	T	.61	6.05
Triangle													
1929-30	.00	.00	4.50	3.00	2.72	1.63	.99	.58	.11	.05	.01	1.26	17.88
1930-31	.90	1.11	.15	.51	1.03	2.18	.51	1.30	.96	.00	.00	.65	9.30
Bieber													
1929-30	.83	.00	4.51	3.78	2.75	.67	.92	1.51	.02	T	.20	1.25	16.47
1930-31	.13	.90	.28	1.38	1.98	1.41	.26	1.37	.31	T	.04	.59	8.98

Comparison With Long Time Record.

Referring to Table 4, the average seasonal precipitation at Alturas for the period of record is 11.43 inches, including the equivalent water content of snow. During the first 16 years of record, extending from 1904 to 1920, the average seasonal precipitation was 12.28 inches, but during the last 6 years of record from 1925 to 1931, the average seasonal precipitation was only 9.15 inches. In other words, during the 16 years prior to 1920 the precipitation at Alturas averaged approximately 107 per cent of the present normal, while during the 6 years ending in 1931, including the 3 years of this investigation, it averaged only about 80 per cent of normal. The seasonal precipitation in 1928–29 was 70 per cent of normal, in 1929–30 87 per cent, and in 1930–31 only 53 per cent, making an average of about 70 per cent of normal for the three year period of investigation.

Snow Surveys.

Snow surveys were made at courses established in the upper Pit River basin as a part of the state-wide program of snow surveys of the Division of Water Resources.

The survey consists of taking numerous snow core samples at certain predetermined points along a specified course, with special sampling apparatus. The depth of the snow and its character, density, and water content are obtained in this manner.

The general purpose of these surveys was to obtain information to afford forecasts of the water supply for the ensuing seasons. In spite of the lack of previous records of snowpack, the observations in 1930 and 1931 were of material assistance to the water users in preparing their irrigation programs so as to make the maximum use of the water supply available.

The three snow courses used were as follows:

Eagle Peak. This course is located at the headwaters of the South Fork of Pit River, in section 35, T. 40 N., R. 15 E., M. D. B. and M., approximately 4 miles east of Jess Valley, at an elevation of about 7500 feet.

Cedar Peak. This course is located at the headwaters of Thoms Creek, in section 12, T. 43 N., R. 14 E., M. D. B. and M., approximately 2½ miles northwest of Cedar Pass, at an elevation of about 7200 feet.

Adin Mountain. This course is located at the headwaters of Ash Creek (via Cottonwood Creek), in section 11, T. 39 N., R. 10 E., M. D. B. and M., approximately 7 miles east of Round Valley, at an elevation of about 6500 feet.

The records obtained at these stations in 1930 and 1931 are submitted in Table 6.

Temperature.

The temperatures encountered in the area are those typical of the high plateau regions of California. The winters are moderately severe and the summers are very warm during the day and cool at night. The mean minimum temperatures during the months of October to April fall below freezing. The mean minimum temperatures for the remaining months of the year range from slightly above freezing for May to about 45 degrees, Fahrenheit, for July. The mean maximum temperatures during the summer months range as high as 89 degrees for the

TABLE 6

SNOW SURVEY DATA FOR UPPER PIT RIVER WATERSHED COURSES, 1930 AND 1931

Snow course	Location	Elevation	1930				1931			
			Date of survey	Depth of snow, inches	Density, per cent	Water content, inches	Date of survey	Depth of snow, inches	Density, per cent	Water content, inches
Eagle Peak	4 miles east of Jess Valley	7,500	April 3, 1930	24.3	45.3	11.0	April 1, 1931	13.3	39.1	5.2
Cedar Peak	2½ miles northwest of Cedar Pass	7,200	Mar. 31, 1930	29.3	44.4	13.0	Mar. 31, 1931	22.1	37.6	8.3
Adin Mountain	8 miles east of Adin	6,500	Mar. 27, 1930	13.3	45.6	6.1	Mar. 27, 1931	6.1	47.3	2.9

month of July. The highest temperature of record at Alturas is 105 degrees, and the lowest 32 degrees below zero.

The average growing season is about 100 days, considered as the interval between the last killing frost in the spring and the first killing frost in the fall. The definition of killing frost is necessarily only relative, however, and is dependent upon the kind of plant considered. For the natural and predominent crops in the area the growing season is approximately 180 days.

The prevailing temperature during the spring and summer seasons is the important factor in determining the rate and quantity of run-off from any given amount of precipitation, whether in the form of rain or snow, and in determining the water requirements for irrigated lands during the growing season.

Table 7 is a summary of the temperature record at Alturas for twenty years. Table 8 shows a comparison of the summarized records of daily temperatures collected at the four climatological stations maintained in connection with this investigation.

TABLE 7

SUMMARY OF TEMPERATURE AT ALTURAS, IN DEGREES FAHRENHEIT

ELEVATION 4360 FEET

Length of Record 20 years

Month	Mean	Mean maximum	Mean minimum	Maximum	Minimum
January	27.9	39.5	16.3	69	—32
February	33.2	44.8	21.5	69	—20
March	38.4	52.3	24.3	79	—29
April	45.6	61.3	29.9	87	11
May	51.9	68.7	35.2	98	15
June	59.5	78.2	40.7	98	24
July	67.2	89.0	45.3	104	29
August	65.0	83.5	42.3	105	24
September	55.9	76.4	35.4	98	15
October	47.5	66.3	28.7	93	7
November*	38.1	52.3	23.8	77	—2
December	29.6	41.8	17.3	67	—23
Annual	46.6	62.8	30.1	105	32

*19 year record.

Effects on Run-off. When the prevailing temperature during storms is above freezing, direct and immediate run-off results, but when the prevailing temperature is equal to or below freezing, precipitation in the form of snow causes little or no immediate surface run-off. In this latter case, when there is an accumulation of snow, its final contribution to the stream flow will depend to some extent upon whether continued freezing weather prevails or whether there are thaws. If freezing prevails during the spring months a larger portion of the accumulation will be dissipated by direct evaporation from the snow itself, thus making the snow pack of less value to increase or prolong stream flow.

Effects on Crops. During the growing season, warm temperatures and sunshine are the important factors in producing full crops, providing there is available the soil moisture required to support the rate of growth. Prevailing warm temperatures increase conveyance losses, soil evaporation and plant transpiration, and hence increase the water requirements. Under such conditions, however, maximum crop yields obtain. While prevailing cool weather reduces water requirements, a shorter stand will occur, with a correspondingly lower yield.

TABLE 8

COMPARISON OF TEMPERATURE IN DEGREES FAHRENHEIT AT JESS VALLEY, ALTURAS, TRIANGLE AND BIEBER, 1929-1931

Season	Jess Valley			Alturas			Triangle			Bieber		
	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum
1929-30												
October										52.5	83	18
November										38.7	70	6
December	39.0	62	14	33.3						39.3	60	14
January	30.1	64	9	24.4	60	-21				28.4	58	16
February	40.0	66	4	37.1	66	8				40.2	64	12
March	41.1	72	6	39.5	72	8	39.2	68	8	42.1	68	8
April	48.4	78	24	47.9	81	17	48.1	78	26	48.7	76	25
May	49.5	80	22	49.2	86	16				51.3	84	24
June	60.5	93	30	58.1	98	24	61.0	97	32	63.1	95	32
July	67.9	96	38	64.8	102	30	66.8	96	34	68.2	98	37
August	64.5	94	35	62.7	98	26	63.4	96	30	64.7	96	31
September	56.0	89	25	52.8	98	19	53.5	86	22	56.6	90	30
1930-31												
October	46.4	74	21	43.1	76	13	41.5	68	16	47.1	76	20
November	39.9	74	12	33.5	68	6	32.4	64	4	39.5	72	12
December	32.9	58	7	27.6	57	-6	28.2	50	0	31.4	55	3
January	33.6	63	1	31.3	62	2	27.8	56	8	33.5	58	4
February	36.1	57	4	33.3	54	11	33.1	54	10	37.6	58	14
March	40.5	70	11	38.5	64	11	37.8	64	12	41.9	70	16
April	46.9	78	18	44.3	76	18	43.5	74	14	48.1	80	22
May	56.8	90	25	54.9	86	24	53.3	92	20	58.4	92	32
June	58.7	90	29	58.4	86	26	57.6	92	26	61.1	96	30
July	71.4	101	40	68.7	102	34	68.5	102	34	70.9	104	38
August	67.6	95	40	65.0	95	34	63.9	94	34	67.5	100	35
September	55.1	92	26	51.4	90	24	49.8	92	18	55.2	95	23

Maximum and minimum taken from observer's reports.

CHAPTER III

WATER SUPPLY

Stream Gaging Stations.

Twenty stream gaging stations were installed on the Pit River and its tributaries as part of this investigation, in order to obtain an estimate of the water crop and of the consumptive use. The locations of these stations are shown on Plate I. The stations are numbered and can thus be identified with their descriptions as given farther on in this chapter. The records of daily discharge cover the three-year period of the investigation, and are available in Water Supply Paper No. 721, Water Resources Branch, U. S. Geological Survey. Hydrographs of the flow at four critical stations are presented on Plate III.

The stations were located at critical points which were selected to serve in as may ways possible in supplying data necessary to a solution of the various problems presented in the investigation. The general locations of the stations were determined from a preliminary study of the area, and care was taken in the selection of each site to insure reliability and accuracy over the entire range of discharge to be encountered. The principal consideration was the existence of a permanent control section, in order to eliminate shifting channel conditions and to insure a fixed stage-discharge relation. The gage equipment was set on the control or immediately above it, and the cable or bridge equipment from which current meter measurements were taken was located at the best possible section near the gage.

In all cases the equipment at the stations consisted of a stilling well and shelter, which housed a vertical staff gage and a continuous water stage recorder. Cables with gaging cars were installed for the wide channels, while suspension foot bridges were used in spanning the narrower streams. The plans for standard gaging station equipment as formulated by the U. S. Geological Survey were followed as closely as applicable to conditions.

The locations and purposes of the various stations were as follows:

Station No. 1, on the *South Fork of Pit River at Jess Valley*, gave a direct measure of the amounts of water available for storage in the proposed Jess Valley Reservoir, as well as a partial measure of the amounts of water available for irrigation uses in the South Fork Valley.

Station No. 2, on *West Valley Creek near Likely*, and at the outlet of West Valley, gave similar data for the proposed West Valley Reservoir.

Station No. 3, on the *South Fork of Pit River near Likely*, and above the head of diversions to the South Fork Valley area, gave a direct measure of the major water supply for that area, and also an indication of the total run-off available for storage on the upper South Fork.

Station No. 4, on *Crooks Canyon Creek near Likely*, was located at the mouth of the canyon and gave an indication of the run-off available for storage in that canyon and also measured a small portion of the irrigation water supply for South Fork Valley.

Station No. 5, on *Fitzhugh Creek near Alturas*, and above the Clark Ranch, also measured a portion of the irrigation water supply for the South Fork Valley.

Station No. 6, on the *South Fork of Pit River near Alturas*, was a summer station at the lower end of South Fork Valley and measured the return water from that area.

Station No. 7, on *Pine Creek near Alturas*, has the longest record in the area, and served as a comparison for flood run-off as well as to measure irrigation supply.

Station No. 8, on *Parker Creek near Alturas*, directly measured the run-off available for storage in the proposed Parker Creek Reservoir.

Station No. 9, on the *North Fork of Pit River near Alturas*, directly measured the total run-off from the North Fork area.

Station No. 10, on the *North Fork of Pit River at Alturas*, served in conjunction with Stations 9 and 11 to determine the run-off from the North and South forks of Pit River at their point of confluence.

Station No. 11, on *Pit River at Alturas*, and immediately below the junction of the North and South forks, measured the run-off from the entire Warner Range watershed, and provided a direct measure of the water supply for Hot Springs Valley.

Station No. 12, on *Pit River near Canby*, and at the outlet of Hot Springs Valley, was maintained as a summer station to measure the return water from that area.

Station No. 13, on *Pit River near Lookout*, in Gouger Neck, measured the total run-off from Pit River tributary to Big Valley.

Station No. 14, on *Ash Creek at Ash Valley*, directly measured the run-off available for storage in the proposed Ash Valley Reservoir.

Station No. 15, a summer station on *Rush Creek near Adin*, measured the irrigation water supply of that stream.

Station No. 16, on *Ash Creek at Adin*, and at the outlet of Round Valley, measured the total run-off of Ash Creek tributary to Big Valley, which gives an indication of the amounts available for storage and for irrigation.

Station No. 17, on *Willow Creek near Adin*, measured the run-off of that stream available for storage and for irrigation.

Station No. 18, on *Widow Valley Creek near Lookout*, measured the irrigation water supply of that stream.

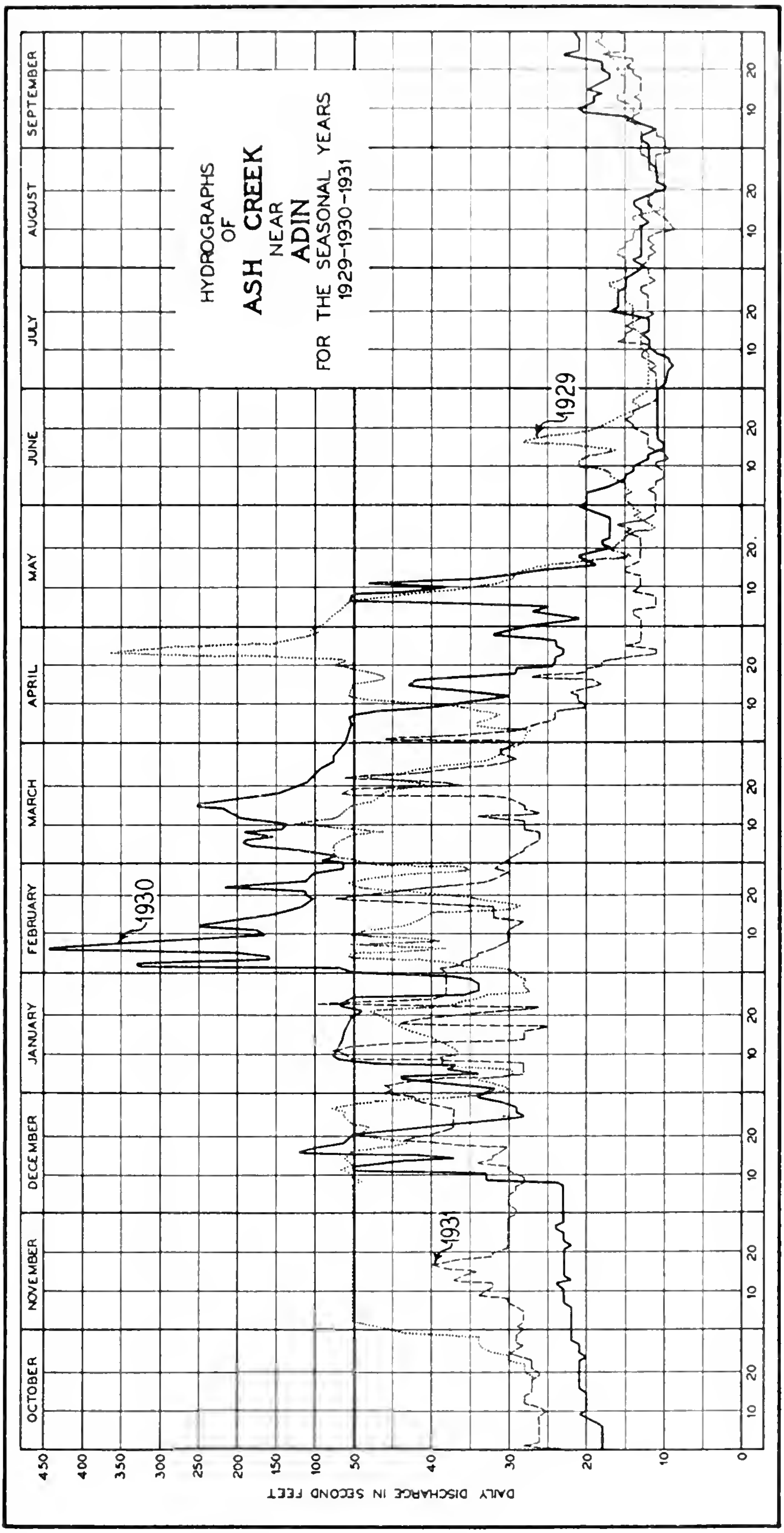
Station No. 19, on *Pit River near Bieber*, and below the outlet of Big Valley, served to determine the total run-off of the upper Pit River watershed.

Station No. 20, on *Horse Creek at Little Valley near Pitville*, and below the outlet of Little Valley, measured the run-off of that stream.

Physical Factors Affecting Run-off.

The run-off of the upper Pit River watershed is affected by three physical features of the basin; shape of the watershed, surface contour and soils.

The shape of the watershed being generally round tends to cause a high concentration of surface run-off whenever general storms or thaws occur, due to the simultaneous contribution of flows from the main stream and its tributaries. The fact that the general surface contour of the watershed is flat or undulated, however, with only about


HYDROGRAPHS
OF
ASH CREEK
NEAR
ADIN
FOR THE SEASONAL YEARS
1929-1930-1931
DAILY DISCHARGE IN SECOND FEET
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
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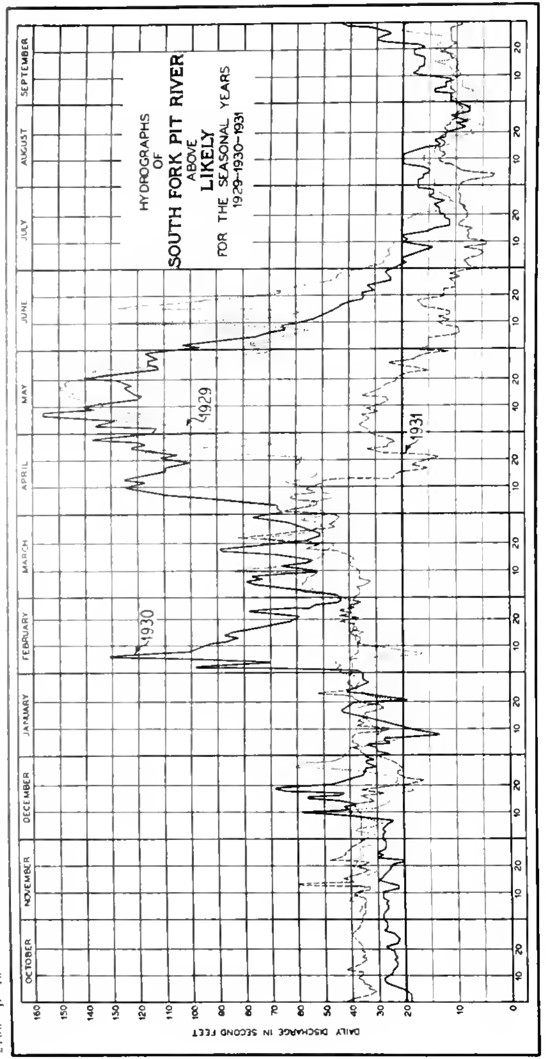
HYDROGRAPHS
OF
SOUTH FORK PIT RIVER
ABOVE
LIKELY
FOR THE SEASONAL YEARS
1929-1930-1931
1929
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OCTOBER
NOVEMBER
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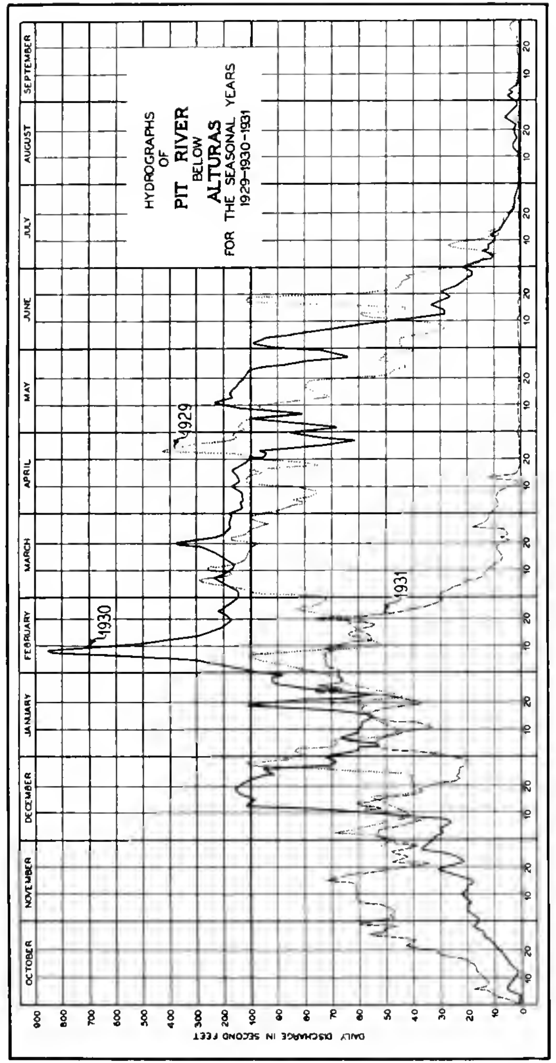
SEPTEMBER
DAILY DISCHARGE IN SECOND FEET


HYDROGRAPHS
OF
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ALTURAS
FOR THE SEASONAL YEARS
1929-1930-1931
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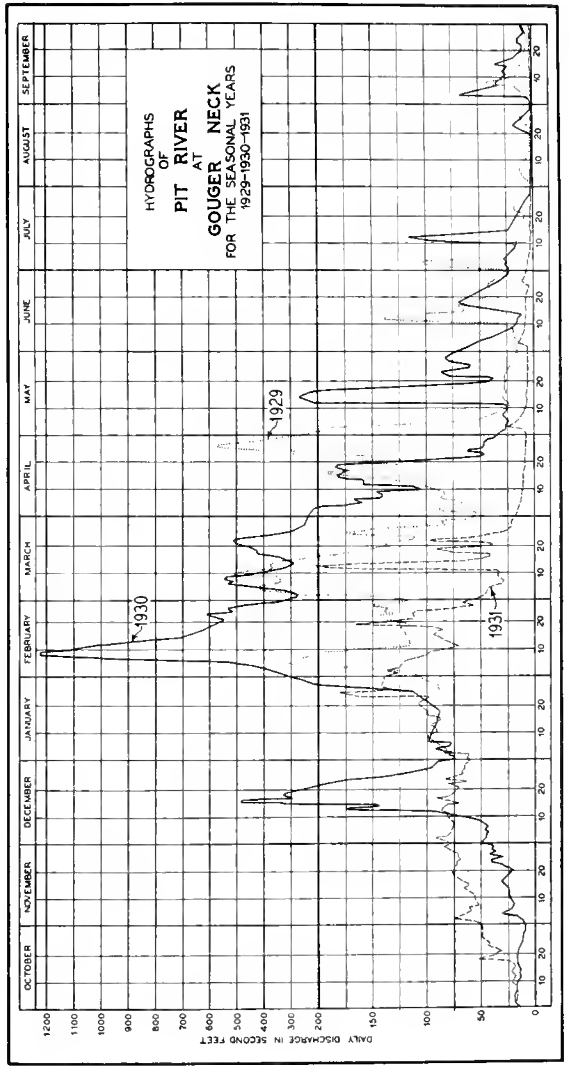
DAILY DISCHARGE IN SECOND FEET


HYDROGRAPHS
OF
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FOR THE SEASONAL YEARS
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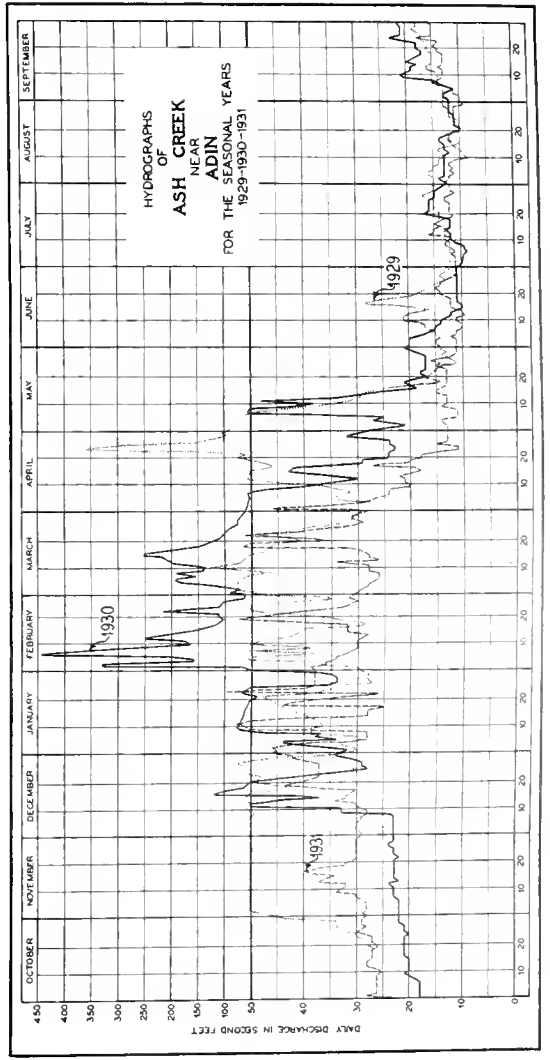
DAILY DISCHARGE IN SECOND FEET


HYDROGRAPHS
OF
ASH CREEK
NEAR
ADIN
FOR THE SEASONAL YEARS
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AUGUST
SEPTEMBER
DAILY DISCHARGE IN SECOND FEET

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25 per cent of the area consisting of steep mountain sides, tends to somewhat flatten out the peaks of run-off which occur.

Clayey soils developed on basalt rocks or consolidated substrata predominate over the area, causing a slow rate of permeability; hence heavy rains and rapid thaws cause almost immediate increments to the surface streams.

Run-off Available for Irrigation.

The irrigating season in the upper Pit River watershed during average years extends from about April 15th to about September 30th, with stockwatering requirements usually extending to about November 1st.

During April and May the irrigation water supply results from a combination of melting snow and rain, and usually exceeds the demand. During June the supply usually decreases very rapidly due to the warmer weather, the exhaustion of the wet-weather springs, and the lack of residual snow. During years of subnormal run-off, plant requirements have exceeded the water supply by the end of June, causing shortages of water in the lower reaches of the various streams. The exceptions to these conditions are on the streams deriving their flows from perennial springs; particularly Ash Creek, Willow Creek, Widow Valley Creek, Horse Creek, and Toms Creek.

During the last three weeks of July, which constitutes the meadow haying season over the major portion of the area, the demand for water decreases to small amounts and there is a surplus caused by two factors; the decrease in plant evaporation and transpiration, and the release of ponded irrigation water. The amounts of released water during years of more plentiful supply have necessitated the construction of various by-pass channels to prevent flooding of the river bottom lands during the haying season.

Following the meadow haying season, and beginning about August 1, the natural water supply along Pit River and its tributaries reaches its lowest stage. During the course of this investigation it was observed that along many streams there was insufficient stock water at times during August, September and October.

Beginning about October 15th, the advent of cooler weather decreases evaporation and transpiration losses, and the stream flows show a sufficient increase to satisfactorily supply the stockwatering demands.

Run-off Available for Storage.

It is assumed that all run-off occurring during the period between November 1st of each year and April 15th of the succeeding year, is available for storage. In addition there will be a certain amount of surplus run-off available for storage during the period between April 15th and about June 1st. It is impossible to make any accurate estimate of this latter amount due to the fact that the existing water rights in the upper Pit River area have not been defined. Accordingly in the estimates of the run-off available for storage made in this report, the surplus water occurring during the period from April 15th to about June 1st has not been included, such exclusion being on the side of conservatism.

25 per cent of the area consisting of steep mountain sides, tends to somewhat flatten out the peaks of run-off which occur.

Clayey soils developed on basalt rocks or consolidated substrata predominate over the area, causing a slow rate of permeability; hence heavy rains and rapid thaws cause almost immediate increments to the surface streams.

Run-off Available for Irrigation.

The irrigating season in the upper Pit River watershed during average years extends from about April 15th to about September 30th, with stockwatering requirements usually extending to about November 1st.

During April and May the irrigation water supply results from a combination of melting snow and rain, and usually exceeds the demand. During June the supply usually decreases very rapidly due to the warmer weather, the exhaustion of the wet-weather springs, and the lack of residual snow. During years of subnormal run-off, plant requirements have exceeded the water supply by the end of June, causing shortages of water in the lower reaches of the various streams. The exceptions to these conditions are on the streams deriving their flows from perennial springs; particularly Ash Creek, Willow Creek, Widow Valley Creek, Horse Creek, and Toms Creek.

During the last three weeks of July, which constitutes the meadow haying season over the major portion of the area, the demand for water decreases to small amounts and there is a surplus caused by two factors; the decrease in plant evaporation and transpiration, and the release of ponded irrigation water. The amounts of released water during years of more plentiful supply have necessitated the construction of various by-pass channels to prevent flooding of the river bottom lands during the haying season.

Following the meadow haying season, and beginning about August 1, the natural water supply along Pit River and its tributaries reaches its lowest stage. During the course of this investigation it was observed that along many streams there was insufficient stock water at times during August, September and October.

Beginning about October 15th, the advent of cooler weather decreases evaporation and transpiration losses, and the stream flows show a sufficient increase to satisfactorily supply the stockwatering demands.

Run-off Available for Storage.

It is assumed that all run-off occurring during the period between November 1st of each year and April 15th of the succeeding year, is available for storage. In addition there will be a certain amount of surplus run-off available for storage during the period between April 15th and about June 1st. It is impossible to make any accurate estimate of this latter amount due to the fact that the existing water rights in the upper Pit River area have not been defined. Accordingly in the estimates of the run-off available for storage made in this report, the surplus water occurring during the period from April 15th to about June 1st has not been included, such exclusion being on the side of conservatism.

In general, areas below 6000 feet produce flood run-off occurring during February, March and the fore part of April, while areas above 6000 feet do not produce such run-off until late in April and during May. Accordingly most of the flood run-off from the watersheds immediately tributary to Big Valley and Hot Springs Valley, and from the plateau and table lands of the North Fork and South Fork valleys, occurs prior to April 15th and is subject to conservation by storage; while that from the streams heading on the summits of the Warner Range does not occur until after the irrigation season commences and can not safely be considered as available for storage.

For an indication of the surplus run-off which has occurred from the entire upper Pit River watershed during the period between November 1st and April 15th reference is made to Table 1 on page 19. Additional tables showing amounts of water available at various proposed reservoir sites are included in Chapter V.

Perennial Springs.

The most reliable sources of water supply in the upper Pit River basin are the perennial springs, which are located at various places in the area. Of particular interest are the springs in the territory south of Likely, those on the floor of Ash Valley, and those on Widow Valley, Willow, Toms and Horse creeks.

The largest are the springs on the floor of Ash Valley, which are open ponds one foot to forty feet in diameter. There are countless numbers of these spring holes covering an area of nearly 2000 acres. The combined flow from them averages approximately 17 second-feet, with very little fluctuation throughout the entire year. The fact that these springs show no apparent diminution even during or following the driest years of record indicates that the source of the water is a large, deep-seated underground reservoir. The temperature of the water is uniformly about 40 to 50 degrees, Fahrenheit.

The springs on Horse Creek, Widow Valley Creek, and Willow Creek are also of the same character. The average flow of Horse Creek is approximately 7 second-feet; of Widow Valley approximately 6 second-feet, and of Willow Creek approximately 5 second-feet.

The combined flow of all of the springs in the vicinity of Likely is approximately 15 second-feet.

Existing Reservoirs.

Some 53 reservoirs have been constructed in the upper Pit River basin, with an aggregate capacity of about 140,000 acre-feet. In practically all instances these reservoirs are located in shallow depressions on the vast expanse of plateau table lands which rim the major valley floors. With one exception, there are no reservoirs situated on the main channels of the river and its major tributaries. The exception is the Toreson (Ballard) Reservoir on Toms Creek south of the town of Canby, which is in the relatively deep canyon of the stream and impounds the run-off from the drainage area above, and in addition is supplied by perennial springs in the channel of the creek. As the remaining reservoirs are not located on "living streams," they are dependent upon short duration run-off of high intensity, in most cases from relatively small contributory watersheds.

The reservoirs range in capacity from 5 acre-feet to 77,000 acre-feet for the Big Sage Reservoir, and their locations and relative sizes are shown on the Irrigation Map. A list of the reservoirs, with essential data pertaining to each, is submitted as Table 9.

The typical dam is constructed of earthfill, in may cases faced with rock. The earth used consists of the adjacent soil, usually of a clay, clay loam or adobe type, which makes a fairly tight dam.

The Big Sage Reservoir is of outstanding importance in the area. It is located in the central portion of the Devil's Garden on the headwaters of Rattlesnake Creek. This reservoir was constructed in 1921 by the Hot Spring Valley Irrigation District, and the water stored is used to supplement the natural flow of Pit River for irrigating approximately 4000 acres of land within the irrigation district, which is situated in Hot Springs Valley. Due to the subnormal years which have prevailed since the reservoir was constructed, it has never been completely filled.

The reservoirs are important sources of irrigation and stock water supply during the latter part of June and during August and September. They are especially valuable as sources of stock water, as their existence makes it possible to utilize the adjacent lands for grazing to their fullest extent.

Due to the prevailing flat plateau terrain, the reservoirs are relatively large in area and shallow in depth. This condition, together with the semiarid climate and the low humidity, causes relatively large evaporation losses.

A study of reservoir losses was made for the Big Sage and Essex Reservoirs. Prior to the run-off season of 1930 automatic recorders were installed on both of those reservoirs, and continuous records of water levels were kept throughout the season. Simultaneously records of release were also kept.

An analysis of the data pertaining to the Big Sage Reservoir lead to two conclusions:

(1) Percolation through the bottom and sides of the reservoir is negligible.

(2) The rate of daily loss in depth varies with the season.

The first conclusion is based upon records during the winter and spring, when evaporation was considered as negligible. It is probably accounted for by the fact that there is a practically impervious layer of clay over the bottom and sides of the reservoir. The reasons for the second conclusion are too obvious to require comment.

Data as to losses from the Essex Reservoir were limited owing to the small amount of water that could be observed, but in general the results agree with those for Big Sage.

TABLE 9

RESERVOIRS IN PIT RIVER INVESTIGATION AREA

Name of reservoir	Owner	Stream	Location			Storage capacity acre-feet	Drainage Area square miles
			Section	Twp.	Range		
Barnes or Indian Springs*	Hoy & Christen	Rock Creek	NW 32	43 N.	12 E.	*510	9
Bayley	McArthur & Christensen	Crooks Canyon	NW 32	40 N.	12 E.	**600	33
Beeler	U. S. Forest Service	Turner Creek	SW 1	42 N.	7 E.	1,000	3
Big Dobe North	Baker & Thomas	Tributary to Rattlesnake Creek	SW 23	44 N.	12 E.	6,530	17
Big Dobe South	Baker & Thomas	Tributary to Rattlesnake Creek	SW 26	44 N.	12 E.	3,860	11
Big Sage	Hot Spring Valley Irrigation District	Rattlesnake Creek	SE 7	43 N.	12 E.	77,000	107
Bowman*	Malinda Bowman	Tributary to South Fork Pit River	N½ 7	40 N.	11 E.	*116	6
"C"	Cooperative Land & Cattle Co.	No name (Devils Garden)	SE 13	44 N.	10 E.	1,450	11
Cable*	S. S. Cable	Tributary to South Fork Pit River	SE 28	40 N.	13 E.	*60	2
Cantrall	Charlotte Cantrall Estate	Tributary to Pine Creek	NE 33	42 N.	13 E.	50	1
Clark or Little Jumper	Clark Bros.	Little Jumper Creek	NE 1	40 N.	13 E.	600	2
Crowder	Lake Shore Cattle Co. et al.	Franklin Creek	NW 7	44 N.	14 E.	100	5
Coyote Flat	C. W. Clark Company	Coyote Creek	SW 31	36 N.	9 E.	5,666	30
Cummings No. 1	John O. Cummings	W. Branch Rock Creek	NW 1	42 N.	11 E.	400	6
Cummings No. 2	John O. Cummings	W. Branch Rock Creek	NW 25	43 N.	11 E.	300	3
Danhauser	Webber & Moffit	Tributary Pine Creek	SE 8	41 N.	13 E.	350	7
Dorris	W. J. & P. S. Dorris	Stockdill Slough	SE 8	42 N.	13 E.	5,900	6
Duke	Royal E. Williams	Tributary to South Fork Pit River	NE 15	39 N.	13 E.	20	1
Duncan	J. S. Potter	No name (Devils Garden)	SW 33	43 N.	9 E.	2,575	11
Emigrant Flat	Baker & Thomas	Tributary to Rattlesnake Creek	SE 31	41 N.	13 E.	563	3
Essex	F. H. Huffman & W. D. Blasingame	Tributary to Pit River	NW 6	42 N.	11 E.	5,000	12
Fleming	J. C. Lane	Tributary to Ash Creek	NE 1	37 N.	10 E.	80	6
French	Frank McArthur	Fitzhugh Creek	SE 16	41 N.	13 E.	150	2
Graven	E. C. Cartwright	Tributary to Canyon Creek	SE 23	40 N.	11 E.	840	6
Huffman Antelope	F. H. Huffman & W. D. Blasingame	Antelope Plains, tributary to Pit River	SW 11	43 N.	10 E.	1,550	36
Ingalls Swamp	W. J. & P. S. Dorris	Tributary to Rattlesnake Creek	SE 27	45 N.	11 E.	650	11
Jacks Swamp	J. S. Potter	Tributary to Pit	NE 28	43 N.	10 E.	450	6
Jesson	Mrs. M. L. Cone	Tributary to Dixie Valley	S½ 17	34 N.	9 E.	1,600	4
Kane*	D. B. Kane et al	Tributary to Pit River	W½ 24	42 N.	9 E.	*150	8
Kelley	Kelley Bros.	Noble Canyon tributary to Pit River	SE 34	43 N.	11 E.	5	3
Kelley (Portuge Flat)	John Kelley & Frank McArthur	Canyon Creek	SE 6	41 N.	11 E.	1,428	6
Kelley & Greiner	Dewey & McHugh	Tributary to Pit River	SE 17	43 N.	14 E.	284	3
Lauer	Lake Shore Cattle Co. et al	Tributary to North Fork Pit River	NW 15	44 N.	13 E.	600	6
Meade Flat*	G. L. Kramer	Taylor Creek	SW 27	40 N.	6 E.	*871	4
Mud Lake	Baker & Thomas	Tributary to Rattlesnake Creek	SW 20	43 N.	13 E.	309	1
Nelson	F. S. Benedict	Dry Creek	NW 24	38 N.	12 E.	400	5

Nelson Spring	J. D. Flournoy	Tributary to South Fork Pit River	SE 33	40 N.	13 E.	60	2
Payne	Frank McArthur	Fitzhugh Creek	NW 15	41 N.	13 E.	2,000	4
Plum Canyon	L. H. Porter & John Page	Shields Creek	NE 32	42 N.	14 E.	180	3
James Porter	J. C. & Mrs. P. E. Porter	Tributary to Parker Creek	NW 1	42 N.	13 E.	200	1
J. L. Porter	Pearl F. Porter	Tributary to Parker Creek	NE 12	42 N.	13 E.	200	1
Roberts (Lower)	H. M. Roberts	Tributary to Pit River	SW 11	39 N.	7 E.	3,970	11
Roberts (Upper)	H. M. Roberts	Tributary to Pit River	SE 29	40 N.	7 E.	933	4
Rye Grass Swale	F. C. Graves et al	Rye Grass Swale tributary to Pit River	SE 25	41 N.	11 E.	**160	14
Silva Flat	Homer Jack et al	Juniper Creek	SW 10	36 N.	9 E.	3,900	20
Spooner	J. J. Fleming & Company	Tributary to Ash Creek	SE 30	37 N.	12 E.	3,123	6
Swanson	Elaf Swanson	East Fork Rattlesnake Creek	SE 18	43 N.	13 E.	300	4
Toreson	F. W. Caldwall & F. L. Kramer	Toms Creek	NW 16	41 N.	10 E.	1,118	9
Upper Pasture	Webber & Moffit	Yankee Jim Slough	NW 3	41 N.	13 E.	250	5
Webb Flat	Gerig Bros.	Taylor Creek	NW 8	41 N.	7 E.	100	5
White	J. M. Fitzhugh	Tributary to Pit River	NE 26	41 N.	10 E.	146	3
Williams	J. S. Potter	No name (Devils Garden)	SE 29	43 N.	9 E.	1,460	6
Woods Flat	Raker & Thomas	Tributary to Rattlesnake Creek	NW 7	43 N.	13 E.	387	3
Total storage capacity						139,087	

* Dams failed prior to 1930. Capacities not included in total.

** Capacities of Bayley and Rye Grass Swale Reservoirs increased in 1932 to 1,200 and 680 acre feet, respectively.

CHAPTER IV

USE OF WATER

Crops.

The major crop in the upper Pit River area is meadow grass hay, varying in quality from lean water grass grown on continuously saturated meadows to rich meadow grass growing where water is applied intermittently. In most areas the natural meadow grasses have been fortified by the sowing of foreign meadow grasses and clovers which are adapted to similar conditions. There is only one cutting of meadow hay per season, occurring during July, at full maturity. Following haying the meadows are again irrigated with whatever water is available, to produce a stand of grass 2 to 10 inches high before cold weather sets in. This latter growth is very valuable for fall pasturage purposes, as it offers the highest type of feed to finish beef cattle before shipping to market.

Approximately 65 per cent of the total irrigated area in the basin is devoted to meadow hay. The high quality "bunch grass" range lands of the plateaus and mountains, together with the green fall pasturage and the meadow hay available for winter feed, make a balanced livestock industry normally yielding substantial profits.

The amount of dry farming in the area is comparatively small. The principle dry land crops are rye, barley and wheat, in order of importance. The production of these crops has decreased during the past two decades owing to the improvement of transportation facilities. Prior to about 1910 these isolated communities were dependent largely upon their own resources for bulk food products such as cereals, fruits, and vegetables. Flour mills formerly in operation at many places throughout the area are now abandoned.

Alfalfa is an important crop on the irrigated lands of the plateaus and sloping lands above the flood-planes of the streams. The acreage producing alfalfa is approximately 12 per cent of the total area of irrigated land in the basin.

Orchards and gardens, though numerous, are not on a commercial scale. However, the quality of their produce is very high, and with the development of sufficient demand, potatoes and apples could be raised in the area which would compete with the best commercial grades.

Detailed crop production census for the area was taken in 1930 and 1931. The data were obtained by means of blanks prepared by the Division and filled out by the water users, and a summary of such information for the entire area is given in Table 10. Complete data of crop production for the individual ranches are contained in Table 46 and a summary of these data arranged by areas is given in Table 47, both submitted at the end of this report.

TABLE 10

SUMMARY OF CROP YIELDS 1930 AND 1931

Crop	1930		1931	
	Average number of irrigations	†Yield per acre	Average number of irrigations	†Yield per acre
Alfalfa	2.4	1.8 tons	1.6	1.4 tons
Meadow hay	5.4	1.5 tons	3.9	0.9 tons
Grain hay	1.9	1.0 tons	1.2	0.9 tons
Mixed hay	0.5	1.0 tons	1.0	0.8 tons
Barley	2.0	11.8 sacks	1.0	6.0 sacks
Oats	1.5	13.3 sacks	1.0	*25.0 sacks
Rye	1.0	7.6 sacks	1.0	No data
Wheat	1.7	7.4 sacks	1.3	8.2 sacks
Sugar beets	3.0	2.0 tons	2.0	Failure
Stock beets	No data	6.0 tons	None	None
Potatoes	3.5	87.8 sacks	2.3	65.7 sacks
Orchard	4.6	2.4 tons	4.7	0.7 tons
Garden	10.9	0.5 tons	8.6	No data
Pasture	7.3		4.4	

†The average yield in 1930 was estimated to be about 80% normal and that in 1931 about 40% normal.
*Report from 2 acres, only.

Irrigated Areas.

The irrigated areas generally fall into the six topographically separated divisions previously mentioned. The problems of water supply and use of water for each of these divisions are more or less independent of the remainder of the watershed, except as affected by return flow from the district immediately upstream.

The major portion of the irrigated areas are bottom lands adjacent to the main streams. Advantage is taken of the natural lay of the sloughs and channels below the flood-plane of the streams to spread the waters across the meadows.

The Irrigation Map shows the irrigated areas in green color. The data as to these areas were platted on the ground on a scale of a quarter of a mile to the inch. This work was done during the fall seasons of each of the three years of the investigation, the flooded condition of the irrigated lands making it impractical to survey them prior to haying. Lands under irrigation at the time of the survey, or which were irrigated in 1928, 1929, or 1930, were classified as irrigated lands. A schematic diagram showing the main irrigated areas and their sources of water supply is presented on Plate IV.

The irrigated lands in the basin are summarized in Table 11. The basic data for this summary are contained in Table 48 at the end of the report. This latter table shows the acreage irrigated under each ownership, with its source of water supply. The ownerships were taken from the county assessor's plats, and checked in the field at the time of survey. Although corrections due to changes of ownerships were made in some cases, all changes in ownership to the fall of 1931 may not have been noted. The property owners are not shown on the irrigation map, but the property lines are shown and it is believed that any piece of property can be identified by the property lines and their relation to the physiography. Table 49 at the end of the report shows the acreage irrigated from each source.

PLATE IV

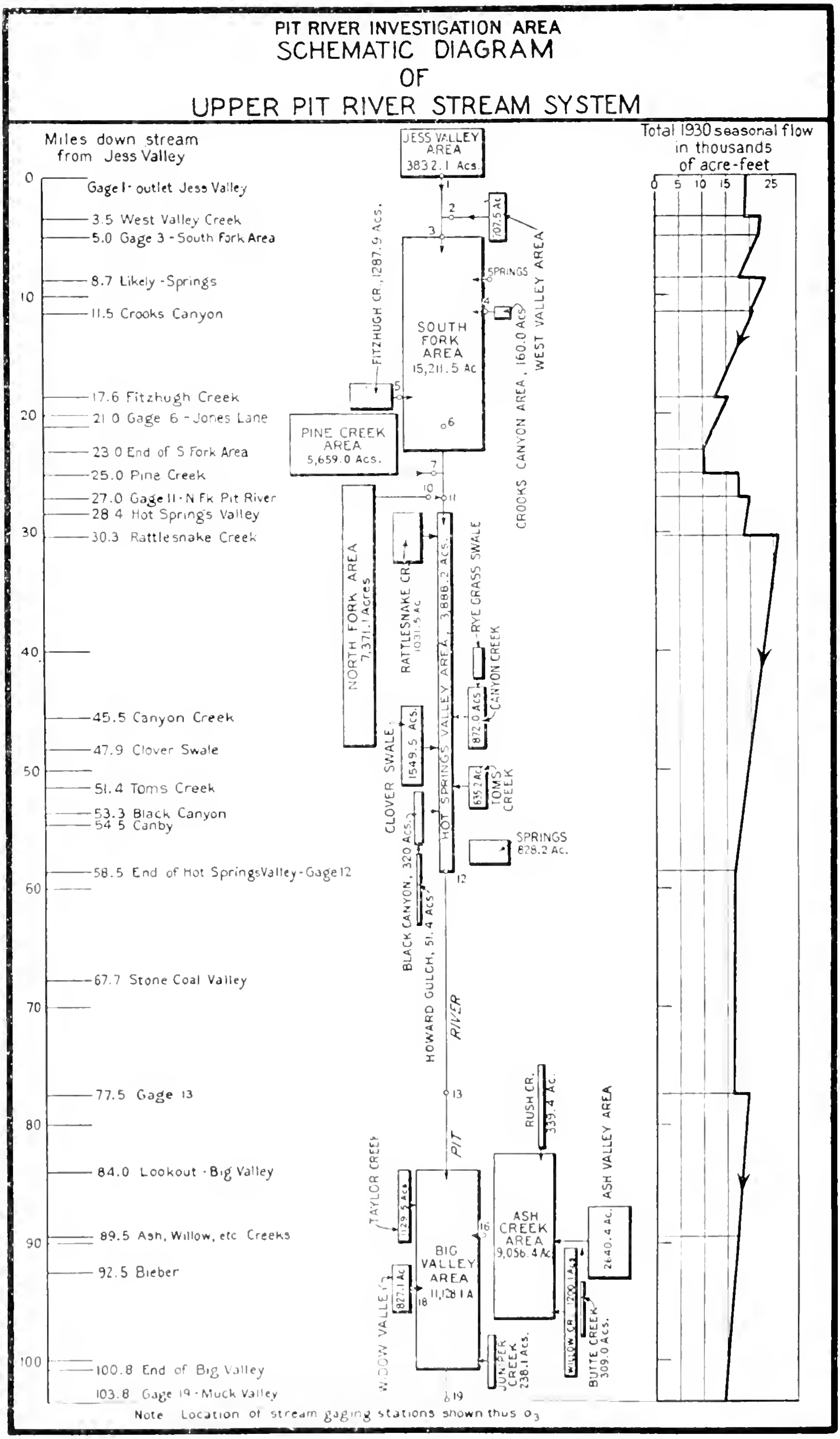

PIT RIVER INVESTIGATION AREA
SCHEMATIC DIAGRAM OF UPPER PIT RIVER STREAM SYSTEM
Miles down stream from Jess Valley
Total 1930 seasonal flow in thousands of acre-feet
0 Gage 1 - outlet Jess Valley
3.5 West Valley Creek
5.0 Gage 3 - South Fork Area
8.7 Likely - Springs
11.5 Crooks Canyon
17.6 Fitzhugh Creek
21.0 Gage 6 - Jones Lane
23.0 End of S Fork Area
25.0 Pine Creek
27.0 Gage 11 - N Fk Pit River
28.4 Hot Springs Valley
30.3 Rattlesnake Creek
45.5 Canyon Creek
47.9 Clover Swale
51.4 Toms Creek
53.3 Black Canyon
54.5 Canby
58.5 End of Hot Springs Valley - Gage 12
67.7 Stone Coal Valley
77.5 Gage 13
84.0 Lookout - Big Valley
89.5 Ash, Willow, etc Creeks
92.5 Bieber
100.8 End of Big Valley
103.8 Gage 19 - Muck Valley
JESS VALLEY AREA 3832.1 Acs.
107.5 Ac
WEST VALLEY AREA
SPRINGS
CROOKS CANYON AREA, 160.0 Acs.
FITZHUGH CR., 1287.9 Acs.
SOUTH FORK AREA 15,211.5 Ac
PINE CREEK AREA 5,659.0 Acs.
NORTH FORK AREA 7,371.1 Acres
RATTLESNAKE CR. 1031.5 Ac
HOT SPRINGS VALLEY AREA, 3,886.2 Acs.
RYE GRASS SWALE
CANYON CREEK
872.0 Acs.
CLOVER SWALE 1549.5 Acs.
635.2 Ac
TOMS CREEK
SPRINGS 828.2 Ac.
BLACK CANYON, 320 Acs.
HOWARD GULCH, 51.4 Acs.
PIT RIVER
RUSH CR. 339.4 Ac.
ASH VALLEY AREA 2640.4 Ac.
TAYLOR CREEK 1129.5 Acs
BIG VALLEY AREA 11,128.1 A
ASH CREEK AREA 9,056.4 Ac
WIDOW VALLEY 827.1 Ac
JUNIPER CREEK 238.1 Acs.
WILLOW CR. 1200.1 Acs.
BUTTE CREEK 309.0 Acs.
Note: Location of stream gaging stations shown thus o3

TABLE 11

SUMMARY OF IRRIGATED ACREAGE

Area	Crop Acreage											
	Meadow hay	Grain hay and meadow hay	Alfalfa and meadow hay	Alfalfa	Grain	Meadow pasture	Pasture	Grain hay	Orchard	Garden	Unclassified	Total
North Fork	7,030.8	34.0	305.9	1,715.3	1,385.5	337.6	576.0	....	30.7	34.3	1,580.0	13,030.1
South Fork	16,848.3	....	163.7	784.0	816.1	501.2	2,059.4	....	3.0	23.3	....	21,199.0
Hot Springs Valley	7,362.4	....	83.4	1,153.0	391.4	....	952.4	....	5.0	35.4	....	9,983.0
Big Valley	7,371.4	520.0	449.3	3,258.2	387.1	168.9	522.4	....	....	21.7	910.0	13,609.0
Ash Creek	5,865.1	125.6	109.1	810.3	541.1	779.5	4,782.8	493.3	7.8	30.7	400.0	13,945.3
Horse Creek	1,710.7	....	....	....	....	....	....	....	....	0.5	....	1,711.2
Totals	46,188.7	679.6	1,111.4	7,720.8	3,521.2	1,787.2	8,893.0	493.3	46.5	145.9	2,890.0	73,477.6

Nonirrigated Agricultural Areas.

The nonirrigated agricultural areas in the basin are shown on the Irrigation Map in yellow, and are summarized in Table 12. These areas were determined by a study of the soil characteristics. It was considered that agricultural lands include those with soils varying from gravelly loams to adobes, but the shallow phases of all types of clay and gravelly soils were excluded.

TABLE 12

SUMMARY OF NONIRRIGATED AGRICULTURAL ACREAGE

Area	Division	Total acreage of nonirrigated agricultural lands	
		For division	For area
North Fork	North Fork valleys	33,128	
	Pine Creek	12,586	45,714
South Fork	Jess Valley	4,769	
	West Valley	1,880	
	South Fork Valley	33,516	40,165
Hot Springs Valley	Hot Springs Valley	63,843	63,843
Big Valley	Pit River	31,149	31,149
Ash Creek	Ash Valley	7,401	
	Round Valley	4,971	
	Big Valley	25,809	38,181
Horse Creek	Dixie Valley	1,711	1,711
Total			220,763

Most of the nonirrigated agricultural lands lie higher in elevation than the present irrigated lands, or are remote from any readily available source of irrigation water. The extent of these lands that are susceptible to irrigation can be determined only by considering the probable costs for the necessary supply and distribution conduits, and this has not been done for this report.

Diversions.

Diversions from the upper Pit River stream system fall into two general classes; direct diversions into ditches or branching sloughs, and "flooded banks" diversions. The former type of diversion is common over the State, but the latter type is peculiar to flat meadow areas such as those of the upper Pit River basin.

The term "flooded banks diversion" is used to designate a diversion made by raising the water level by a temporary dam to a point a few inches higher than the banks of the channel, thus causing the water to flood out over the banks hundreds of feet onto the adjacent low-lying meadows. As is usual with streams on a flat valley floor, the banks of the upper Pit River have been built up higher than the surrounding meadows, so that this type of diversion is found to be satisfactory. In many instances both banks of the stream are completely inundated for more than a half mile above the flooding dam.

Direct diversions into ditches usually occur near the heads of the irrigated areas or along streams that have considerable gradient. Diversions into branching sloughs occur mainly on the valley floors. The sloughs are usually highwater channels which relieve the main channel

during floods, and diversions into them are made by means of check structures at their heads. Rediversions from the sloughs are usually made by the "flooded banks" method.

There are two types of diversion works in general use; small temporary or semi-permanent earth, rock, brush, or timber structures in the smaller streams at the heads of ditches, and permanent removable type structures with timber flashboards along the main river channel on the valley floors.

The plan of construction of all of the main river and slough dams provides for the removal of flashboards and supports in the fall to allow unobstructed river flood flow during the spring high water. These dams are operated during the irrigating season by the manipulation of sufficient top flashboards to raise the water level above the dam to the desired elevation, or to pass the necessary flow downstream over the top, as the case may be. The dams are made of wood or concrete with a transverse floor and vertical wall bulkheads. Cross logs spanning the channel act as the upper bearing either for the vertical post supports against which horizontal flashboards are placed, or for vertical needle flashboards extending from the floor sill to the top log. There are approximately 42 dams of this type on the river channel itself between Likely and the lower end of Big Valley, and as many more on main sloughs within the irrigated areas. The height of these dams varies from 4 to 16 feet, with widths ranging from 12 to 70 feet.

The conveyance channels for the irrigation supply on the valley floors, other than the river itself, consist of sloughs and natural drains which intersperse the irrigated meadows. These natural conveyance channels satisfactorily meet all the requirements of a good distribution system at a comparatively low cost, and serve for both irrigation supply and flood flow drainage.

Conveyance losses in the river and slough channels within the irrigated areas are unmeasurable because of the methods of diversion and distribution practiced, and have been considered as a part of the consumptive use.

Records of measurements of diversions are submitted in Table 50 at the end of this report.

Methods of Irrigation.

The "wide-spread flooding method" is the one commonly used in the upper Pit River area. The meadows, being practically flat and interspersed with sloughs, are covered with ponds of water by means of conveniently located check-levees, sufficient only to retard the wide-spreading waters and force still further lateral spreading. The process consists first of filling and flooding the upper lands by means of the upper series of check dams and levees, and then dropping the accumulated water across the next lower lands, and so on over each piece of property or each group of adjacent properties. The "carry-over" or "return" water is then picked up by the next river or slough dam for the next lower irrigated area. In this manner of use, a large initial "starting-head" of water at the diversion point is essential for good results. The same water may be consecutively carried over many ranches, however, covering many hundreds of acres before its final dissipation or return to the river for rediversion. Under these condi-

tions the important factor in the problem of delivering irrigation water is to keep the river water surface high enough to maintain a satisfactory high rate of diversion flow to meet the starting-head requirements.

The frequency of irrigation of the meadows depends largely upon the prevailing temperature conditions, but in general it has been observed that complete flooding, with sufficient time for satisfactory soil penetration, should occur every 15 to 20 days; making about four irrigations between about April 15th and haying time.

The method of irrigation on the sloping lands is that of "wild-flooding." This method is largely confined to use on alfalfa and grain lands which are irrigated by delivery ditches. It consists of taking out water from numerous delivery boxes or side take-outs and allowing it to spread out fanwise down the slope, usually to be collected in the next lower distribution ditch.

Subirrigation is practiced on only a small portion of the lands in the area. In many places along the main conveyance channels the banks are too high to permit flooding during the irrigation season, but the proximity of the water with the resultant high ground-water plane on adjacent lands makes it practical to grow alfalfa thereon. The largest area of subirrigated lands is the region east of Lookout that extends north along the banks of Pit River for a distance of 10 miles.

Perennial springs, where situated on the floor of the valleys in the midst of the meadow lands, as are found in Ash Valley, offer a unique means of irrigation. These springs are usually open ponds on the meadow floor ranging from one foot to 40 feet in diameter, and the water surface in the spring-holes is at about the level of the grass roots. There are scores of these springs, and they cause the adjacent soil to be saturated at all times.

Water Requirements.

On account of the "wide-spread flooding method" of irrigation practiced on the meadow lands along the upper Pit River, three factors must be considered in connection with the water requirements for the irrigation of those lands; namely, the amount of water required as a "starting head," the amount required as "carry-over water," and the net consumptive requirements of the lands and river and slough channels passing through them.

Starting-head. Under such irrigation practices it is necessary to supply large initial heads of water in the channels to afford high rates of diversion. These starting-heads must be derived from temporary channel storage retained above the diverting dams. The exact amounts so required are difficult to measure, but observations of supply and delivery in Hot Springs Valley during the 1931 season indicate that the starting-head amounted to approximately 1000 acre-feet, which wave was allowed to drop down over each ranch, consecutively. The maximum rate of diversion was estimated as approximately 400 second-feet.

Carry-over Water. The irrigation of the meadow lands along the river bottoms requires a certain amount of water, in excess of the actual consumptive use, to support the irrigation water so that it will spread widely over the flat lands. This "carry-over" or "accessory" water averages approximately 20 per cent of the gross delivery to an irri-

gated area, but the proportion varies with the season and ranges from 5 per cent to 10 per cent during the cooler early part of the growing season to considerably in excess of the 20 per cent figure during the hotter period in summer. The seasonal variation in this carry-over water requirement is also due to the rapid growth of the meadow grass stems which hamper and retard the lateral wide spreading of the water. The carry-over water, though essential to the proper irrigation of the meadows, is all returned to the stream below the irrigated area, all losses being charged to net consumptive use.

Net Consumptive Requirements. These requirements include water consumed by evaporation, deep percolation, plant transpiration, and conveyance losses within the irrigated areas. Because of the involved irrigation systems used, it was impractical to attempt to determine these requirements for the individual ranches, but the net consumptive uses on certain areas which were treated as units have been determined by the measured differences between the quantities of water delivered into the areas and the quantities of water flowing out of the lower ends.

Table 13 shows the measured net seasonal consumptive use on certain areas which have been treated as units.

TABLE 13

NET SEASONAL CONSUMPTIVE USE ON CERTAIN AREAS

1930 and 1931

Area	Season	Net consumption, acre-feet	Irrigated acreage	Net use of water, acre-feet per acre
Supplied by Adequate Flows from Perennial Springs				
Geo. Williams and McGarva Springs	1930	4,356	1,219	3.57
	1931	3,992	1,219	3.28
All springs near Likely	1920	5,442	1,296	4.20
	1931	5,442	1,296	4.20
Widow Valley Creek	1930	1,481	718	2.10
	1931	1,277	718	1.80
Willow Creek	1930	1,935	1,091	1.80
	1931	1,711	1,091	1.69
Ash Creek	1930	1,508	1,379	1.09
	1931	1,988	1,379	1.41
Supplied by Inadequate Flows Supplemented by Storage Water				
Pine Creek	1930	12,567	6,652	1.89
	1931	4,363	6,652	0.66
Meadows in Hot Springs Valley	1930	9,009	4,207	2.14
	1931	5,389	4,207	1.28
Under Kelley Ditch in Hot Springs Valley	1930	552	205	2.69
	1931	525	205	2.56
Supplied by Inadequate Flows				
South Fork Pit River, exclusive of springs	1930	11,699	12,688	0.93
	1931	6,432	12,688	0.51
Big Valley	1930	15,153	22,050	0.69
	1931	8,975	22,050	0.41
Under Pit River Dam and Ditch Company, ditch from North Fork Pit River	1930	1,541	1,604	0.96
	1931			

The measured seasonal consumptive use of water in the several areas varies from 4.2 acre-feet for lands adequately watered from springs to 0.41 acre-foot for the inadequately watered lands in Big Valley in 1931. The remaining areas reported show various values in between these two extremes, and in general it may be said that the amount of water consumed in each area is largely dependent upon the adequacy of the water supply.

The monthly distribution of the measured use for 1930 and 1931 in four of the upper Pit River areas is summarized in Table 14, and the results are shown graphically in Figure 1 of Plate V.

TABLE 14

NET MONTHLY CONSUMPTIVE USE ON FOUR AREAS IN ACRE-FEET PER ACRE

1930 and 1931

Area	Season	April*	May	June	July	August	September	Seasonal total
South Fork Pit River	1930	0.21	0.28	0.19	0.08	0.07	0.10	0.93
Hot Springs Valley	1930	0.38	0.79	0.49	0.03	0.26	0.19	2.14
	1931	0.30	0.59	0.39	0	0	0	1.28
Willow Creek	1930	0.45	0.36	0.22	0.21	0.25	0.27	1.76
	1931	0.31	0.31	0.25	0.21	0.23	0.27	1.58
Widow Valley Creek	1930	0.43	0.36	0.29	0.34	0.33	0.32	2.07
	1931	0.31	0.24	0.25	0.30	0.29	0.37	1.74

* April 15th to 30th.

Desirable Net Seasonal Use. The desirable net seasonal use for any area is considered as the amount of water necessary to supply the total consumptive requirements during a normal irrigation period extending from April 15th to September 30th.

Observations of precipitation, run-off, crop yields and irrigation conditions indicate that of the three years of the investigation the 1930 irrigation season was the most nearly normal. It is estimated, considering all factors, that that season was approximately 84 per cent of the average for the past twenty years. Applying this factor to the measured monthly uses of water as shown in Table 14, the estimated normal monthly quantities of water that will be available and used have been computed for the South Fork and Big Valley areas, as shown in Table 15. The desirable monthly quantities for each of the areas are also shown in the table, having been determined by comparison with other areas where ample water supplies were available to permit full use throughout the season. The differences between the estimated normal quantities of water available and used, and the estimated desirable amounts, give the additional net monthly supplies that it is concluded must be provided by storage in order to permit full development.

TABLE 15

ESTIMATED DESIRABLE SEASONAL NET CONSUMPTIVE USE

Acre-Feet per Acre

Area	Item	*April	May	June	July	Aug.	Sept.	Seasonal total
South Fork Pit River.	Estimated present normal use	0.25	0.33	0.23	0.10	0.08	0.12	1.11
	Additional supply needed	0	0	0.20	0.05	0.30	0.05	0.60
	Estimated desirable use	0.25	0.33	0.43	0.15	0.38	0.17	1.71
Big Valley	Estimated present normal use	0.50	0.50	0.20	0.10	0.15	0.10	1.55
	Additional supply needed	0	0.10	0.40	0.05	0.25	0.10	0.90
	Estimated desirable use	0.50	0.60	0.60	0.15	0.40	0.20	2.45

* April 15th to 30th.

The data from Table 15 are shown graphically in Figures 2 and 3 of Plate V.

Stock Water Requirements are usually incidental to irrigation requirements during the irrigating season. During the fall and winter seasons, however, stock water requirements are the important consideration in the distribution of the low flows normally prevailing. In the lower portions of some of the areas, particularly in South Fork Valley and Big Valley, the problem of supplying sufficient stock water during the period from August to October is usually a serious one under present conditions.

Return Water.

In this report "return flow" or "return water" is considered as water which flows back into conveyance channels, either streams or sloughs, from the adjacent irrigated lands. Where the wide-spread flooding method of irrigation is practiced on the valley floor meadow lands, this return water is principally in the nature of "carry-over" water, as previously described.

Except following heavy rains or late thaws, it is the practice of each water user on the valley floors to divert practically the entire flow of the stream over his meadow, and to allow the surplus water to return to the channel for rediversion by his neighbor next below. In Hot Springs Valley alone the water supply in Pit River is diverted, spread over meadows, and returned to a conveyance channel sixteen consecutive times before passing out of the valley. Such re-use occurs generally throughout the entire length of the upper Pit River and its tributaries.

In Table 16 wide variations of percentage of return water are noted. The practical failure of the water supply in 1931 renders that year's data irrelevent to ordinary conditions. The usual amount of return water from meadow lands on the valley floors ranges from 20 per cent to 25 per cent of the total amount of water supplied at the head of the area.

PLATE V

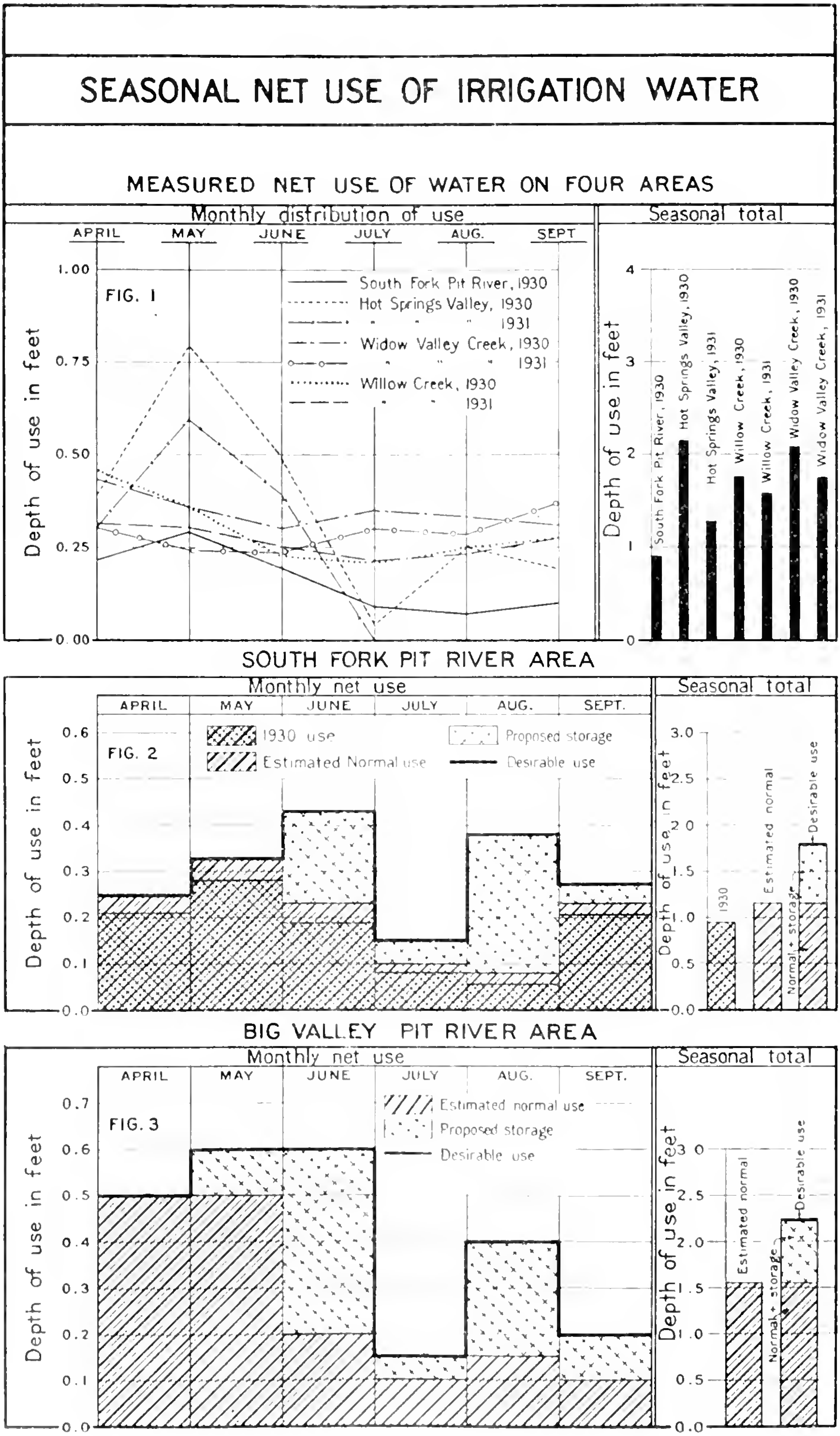

SEASONAL NET USE OF IRRIGATION WATER
MEASURED NET USE OF WATER ON FOUR AREAS
Monthly distribution of use
Seasonal total
APRIL MAY JUNE JULY AUG. SEPT
FIG. 1
South Fork Pit River, 1930
Hot Springs Valley, 1930
" " 1931
Widow Valley Creek, 1930
" " 1931
Willow Creek, 1930
" 1931
Depth of use in feet
1.00 0.75 0.50 0.25 0.00
4 3 2 1 0
South Fork Pit River, 1930
Hot Springs Valley, 1930
Hot Springs Valley, 1931
Willow Creek, 1930
Willow Creek, 1931
Widow Valley Creek, 1930
Widow Valley Creek, 1931
SOUTH FORK PIT RIVER AREA
Monthly net use
Seasonal total
APRIL MAY JUNE JULY AUG. SEPT.
FIG. 2
1930 use
Estimated Normal use
Proposed storage
Desirable use
0.6 0.5 0.4 0.3 0.2 0.1 0.0
3.0 2.5 2.0 1.5 1.0 0.5 0.0
1930
Estimated normal
Normal + storage
Desirable use
BIG VALLEY PIT RIVER AREA
Monthly net use
Seasonal total
APRIL MAY JUNE JULY AUG. SEPT.
FIG. 3
Estimated normal use
Proposed storage
Desirable use
0.7 0.6 0.5 0.4 0.3 0.2 0.1 0.0
3.0 2.5 2.0 1.5 1.0 0.5 0.0
Estimated normal
Normal + storage
Desirable use

TABLE 16

RETURN WATER FROM CERTAIN MAJOR AREAS

Area	Season	Total seasonal acre-feet supply	Total seasonal acre-feet return	Per cent of return
South Fork above Jones Lane	May-Sept., 1929	20,685	3,655	17.7
	May-Sept., 1930	19,794	5,936	30.0
	April-Sept., 1931	11,874	297	2.5
Pine Creek	June-Sept., 1929	10,567	2,784	26.3
	May-Sept., 1930	19,781	9,727	49.2
	April-Sept., 1931	4,607	244	5.3
Hot Springs Valley	May-Sept., 1930	17,912	9,715	54.2
	April-Aug., 1931	7,282	1,124	15.4
Big Valley	May-Sept., 1930	17,904	5,188	29.0
	April-Sept., 1931	9,743	768	7.9

In the South Fork area, in 1929 the water supply was deficient: hence the return was lower than the average. In 1930 the supply was slightly above normal during the early irrigation months and the return was consequently larger than might be expected during average years. The mean value of approximately 25 per cent is considered as the normal return flow from the South Fork area.

In the Pine Creek area, in 1929 the water supply, including Dorris Reservoir releases, was nearly satisfactory. In 1930 there was a surplus of supply and water was used freely in some instances, so that the return that year was above normal. The estimated normal return flow for the Pine Creek area is 25 per cent. or approximately that observed in 1929.

In Hot Springs Valley, excessive and unregulated releases from Big Sage Reservoir in 1930 account for the unusually high return water ratio that year. In 1931 the water supply was deficient and unusual care was exercised to prevent waste; accordingly the return water that year was below normal. It is estimated that the return flow in Hot Springs Valley under normal conditions will be from 20 per cent to 25 per cent.

In Big Valley, heavy precipitation occurred in 1930 in the Juniper Creek and lower Ash Creek areas, the run-off from which was unmeasured except as return water issuing from the area at Muck Valley. Consequently the ratio shown in the table is somewhat higher than may be expected under normal conditions. By comparison with the results for Hot Springs Valley it is estimated that the normal return flow for Big Valley is about 20 per cent.

Stream Administration.

The need for some manner of coordination and regulation of diversions on the upper Pit River stream system, with its widely fluctuating flows, was apparent to the water users before the Division commenced its investigation. Rotation schedules had been attempted in certain areas, but could not be made effective because of lack of proper coordination among the water users. The presence of the Division's engineers in the area in connection with the investigation afforded the

water users an opportunity to obtain stream administration at a minimum cost.

At a meeting of the Big Valley water users held at Bieber on June 6, 1929, plans were formulated and an agreement entered into providing for supervision of diversions from Pit River in Big Valley during the 1930 season, by the resident engineer on the Pit River investigation. The results of this regulation were satisfactory and a similar agreement was entered into for the 1931 season.

In 1931 the stream administration was extended by water users' agreements to include Hot Springs Valley, the Pine Creek area, and the lands irrigated from Parker Creek. The distribution of the waters of the South Fork of Pit River for stock watering purposes during August and September of 1931 was also placed in the hands of the Division by agreement of the parties involved.

Reports covering the details of the work in each instance have been prepared by the Division, as follows:

> Report on Supervision of Diversions from Pit River in Big Valley, 1930 Season, by Irvin M. Ingerson.
>
> Report on Supervision of Diversions from Pit River in Big Valley, 1931 Season, by Irvin M. Ingerson.
>
> Report on Supervision of Diversions from Pit River and Rattlesnake Creek in Hot Springs Valley, 1931 Season, by Irvin M. Ingerson.
>
> Report on Water Master Service on Pine Creek, 1931, by F. G. Montealegre, Jr.
>
> Report on Water Master Service on Parker Creek, 1931, by F. G. Montealegre, Jr.
>
> Report on Water Master Service on South Fork of Pit River, 1931, by Leslie C. Jopson.

Under the terms and intentions of the various agreements the Division's engineer was required to institute and supervise comprehensive schedules of rotation so as to afford a series of satisfactory irrigations to each water user, to correct instances of unnecessary waste of water, to supervise the maintenance and operation of the irrigation dams in order to assure the proper coordination, and to collect data as to quantities of water used. Thus the water supervision facilitated the collection of accurate records pertaining to the use of water, as required in the investigation.

The successful coordination of the many diversions along the streams required constant and vigilant observation of the amounts of water available, of the manner of its use, of the quantities of water being diverted, of the time of travel of the irrigating heads across the meadows, and of the amounts of waste and return water. Usually a time schedule of diversion and use was determined extending a few days in advance of the irrigation head, and each successive water user was notified of his schedule. Owing to variable water supply and temperature conditions it was not always possible to keep the bulk of the irrigation wave moving down through the area exactly on the

prearranged schedule; nevertheless, the variations from the schedule were not serious, amounting to not more than a day or so at the most. After one irrigation wave had been carried down through a particular area the whole program was repeated by starting at the head of that area with another irrigation wave.

CHAPTER V

ANALYSES OF PROPOSED STORAGE PROJECTS

The upper Pit River watershed embraces an area of nearly two million acres and has within its confines about two hundred ninety-four thousand acres of agricultural land, of which some seventy-three thousand acres are irrigated. The irrigated lands lie in the valleys of the main river and its larger tributaries, and in meandering strips adjacent to the smaller streams.

In general, the areas presently irrigated include all the lands that can be readily and economically developed with the available water supply under the present systems of irrigation; hence any material increase in irrigation development in the basin, either irrigation of new lands or the improvement of the water supply for the old lands, will have to come through the development of storage.

An analysis of the data at hand indicates that no one storage project can be developed suitable to conserve the water supply available within the basin, for the benefit of the area as a whole. Furthermore, from an economic standpoint it does not appear feasible to develop any projects in the near future which contemplate the irrigation of any considerable amount of new acreage. Consequently, this discussion of storage developments is confined to projects mainly providing a supplemental water supply for lands now irrigated.

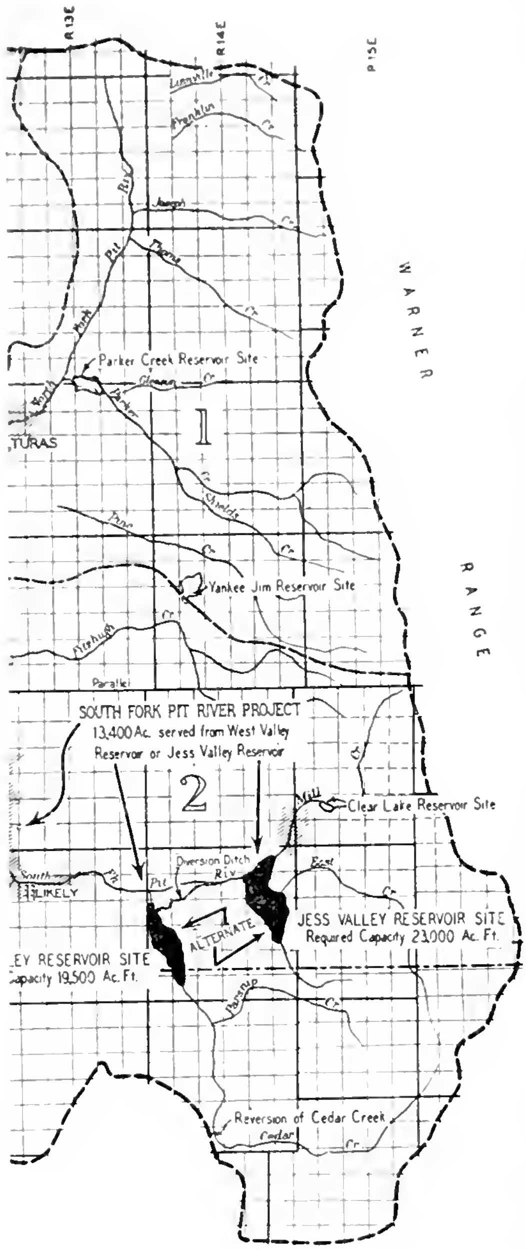
While a large number of suggested reservoirs were inspected in the field, most of these did not appear sufficiently favorable to warrant discussion in this report. Thirteen sites are discussed in this chapter, of which only four appear feasible in the final analysis.

Three suggested reservoir sites for the conservation of the waters of the North Fork basin were investigated: one on the lower end of Parker Creek, another in the Yankee Jim Basin, and a third located on the main North Fork at the narrows just below the junction of Parker Creek. The latter was not seriously considered as the development would involve the cost of removal and relocation of a standard gage railroad and a lateral of the State Highway, which would be prohibitive.

The topography of the South Fork basin indicates four reservoir possibilities: Jess Valley, West Valley, Clear Lake, and an enlargement of the Bayley Reservoir. The Jess Valley and West Valley sites are discussed in detail, as either appears favorable as a project for the relief of the water shortage in the South Fork area.

A study of the topography of the Hot Springs Valley area indicates that there are no major reservoir sites remaining. Private interests have already developed most of the smaller economical locations. A study of the run-off characteristics of the Big Sage drainage area was made to determine the possibility of irrigating more lands from Big Sage Reservoir.

The ideal location for a reservoir for the benefit of the Big Valley area would be on the main river in the canyon below Hot Springs Valley, as such a site would also provide a means of regulating the widely varying return flows from the Hot Springs Valley area to conform to the requirements of the lower area. The entire length of the canyon was investigated and seven sites were selected for study, includ-

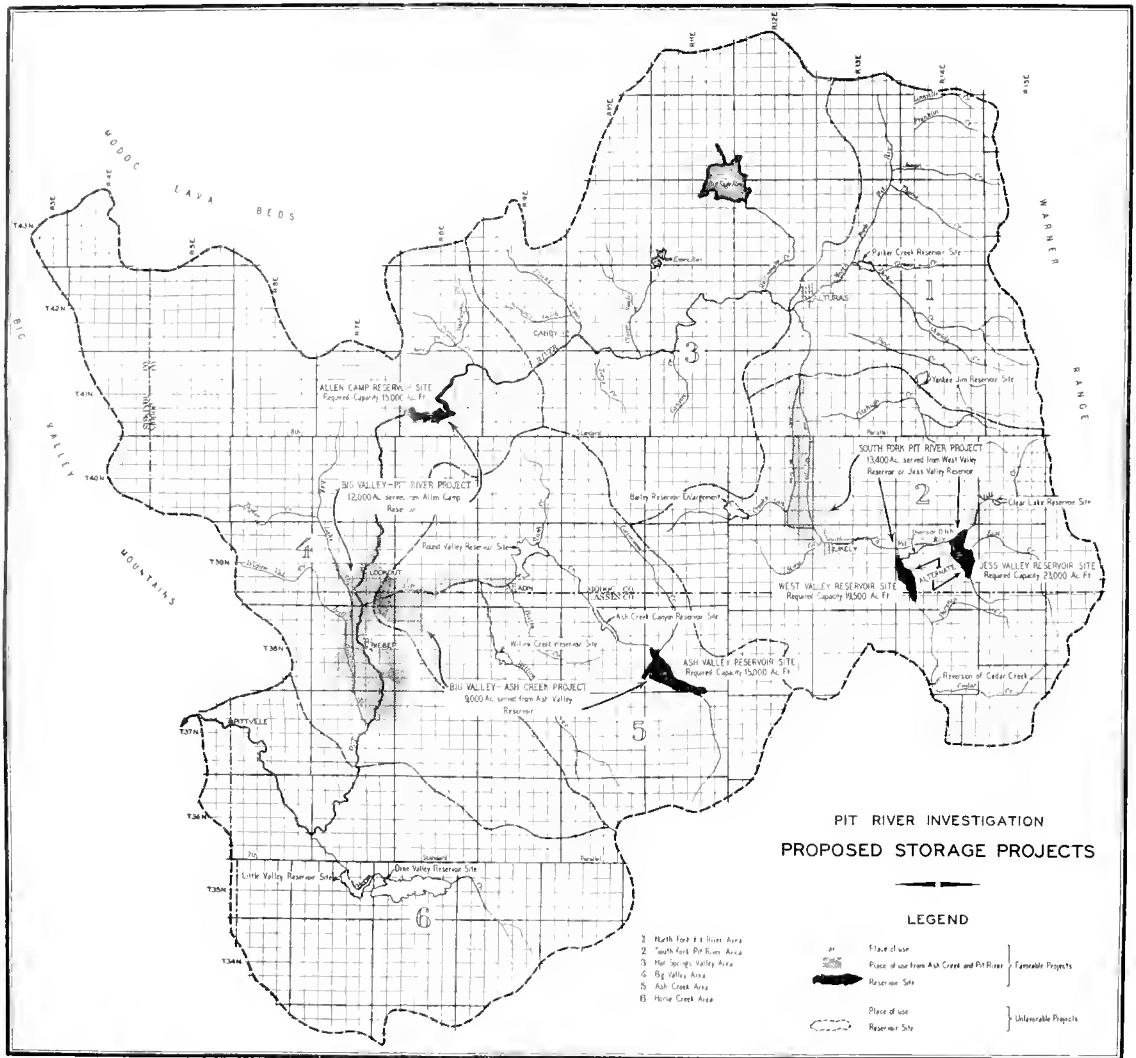


PIT RIVER INVESTIGATION

POSED STORAGE PROJECTS

LEGEND

or	Place of use	Favorable Projects
	Place of use from Ash Creek and Pit River	
	Reservoir Site	
	Place of use	Unfavorable Projects
	Reservoir Site	


MODOC LAVA BEDS
BIG VALLEY MOUNTAINS
WARNER RANGE
ALTURAS
CANBY
LOOKOUT
BIEBER
ADIN
LIKELY
PITTVILLE
MODOC CO.
LASSEN CO.
ALLEN CAMP RESERVOIR SITE
Required Capacity 15,000 Ac. Ft.
BIG VALLEY-PIT RIVER PROJECT
12,000 Ac. served from Allen Camp Reservoir
Round Valley Reservoir Site
Bayley Reservoir Enlargement
SOUTH FORK PIT RIVER PROJECT
13,400 Ac. served from West Valley Reservoir or Jess Valley Reservoir
Clear Lake Reservoir Site
JESS VALLEY RESERVOIR SITE
Required Capacity 23,000 Ac. Ft.
WEST VALLEY RESERVOIR SITE
Required Capacity 19,500 Ac. Ft.
ALTERNATE
Ash Creek Canyon Reservoir Site
Willow Creek Reservoir Site
ASH VALLEY RESERVOIR SITE
Required Capacity 15,000 Ac. Ft.
BIG VALLEY-ASH CREEK PROJECT
9,000 Ac. served from Ash Valley Reservoir
Parker Creek Reservoir Site
Yankee Jim Reservoir Site
Reversion of Cedar Creek
Little Valley Reservoir Site
Dixie Valley Reservoir Site
1
2
3
4
5
6
T43N
T42N
T41N
T40N
T39N
T38N
T37N
T36N
T35N
T34N
1 North Fork Pit River Area
2 South Fork Pit River Area
3 Hot Springs Valley Area
4 Big Valley Area
5 Ash Creek Area
6 Horse Creek Area
PIT RIVER INVESTIGATION
PROPOSED STORAGE PROJECTS
LEGEND
Place of use
Place of use from Ash Creek and Pit River
Reservoir Site
Favorable Projects
Place of use
Reservoir Site
Unfavorable Projects

ing one previously surveyed by Messrs. A. M. Green and Max Green. The problem finally resolved itself into determining the location which would provide a suitable dam site and also a spillway capable of passing a flood of 50,000 second-feet. A geological investigation of the possible dam and spillway sites was made in November, 1932, by Mr. Chester Marliave, engineer-geologist of the Division, and the report on this investigation is submitted as Appendix C to this report. After an analysis of all the data available, the Allen Camp reservoir site was selected as the most favorable one.

Four reservoir sites within the Ash Creek area were investigated as possible storage projects; one on Willow Creek and three on Ash Creek. An inspection of the Butte Creek watershed showed no feasible reservoir site located so as to fully benefit the present irrigated land in the area.

In the Horse Creek area the basins of Dixie Valley and Little Valley offer reservoir sites, and both were investigated.

The estimates of run-off available for storage at the various sites are based upon a period of 13 years extending from 1918 to 1931, except for the Big Sage and Bayley reservoirs, where a 27-year period is used as a basis.

The average run-off for these periods is considerably below normal, consequently the estimates of water yield based thereon are well on the side of safety. This is especially true of the 13-year period, which covers the dry cycle through which the State is now passing.

In estimating the run-off available for storage for the projects in the North Fork and South Fork areas the records of stream flow on Pine Creek near Alturas were used for comparison, while the estimates of run-off for the projects in the Ash Creek and Pit River areas in Big Valley were largely based upon comparisons with the long time record of the flow of Pit River near Bieber. The Big Sage Reservoir record covering a period of ten years was extended by comparison with the record of precipitation at Alturas. The Bayley Reservoir record was extended by a comparison of the three-years record of run-off at Crooks Canyon obtained during the investigation, with the record of precipitation at Alturas.

The locations of the thirteen reservoir sites analyzed are shown on Plate VI. The reservoir sites found to be unfavorable are indicated only in outline, while for the favorable projects they are shown in solid black, and the proposed places of use as cross-hatched areas.

Parker Creek Reservoir Site.

The area which can be directly benefited by this project is approximately 1700 acres of alfalfa land contiguous to the North Fork of Pit River above Alturas.

The estimated amount of water available for storage, based upon a comparison of the watershed with that of Pine Creek, is shown in Table 17, and the area and capacity data for the reservoir, based upon a planetable survey made by the Division in 1931, are presented in Table 18.

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Parker Creek Reservoir Site.

The area which can be directly benefited by this project is approximately 1700 acres of alfalfa land contiguous to the North Fork of Pit River above Alturas.

The estimated amount of water available for storage, based upon a comparison of the watershed with that of Pine Creek, is shown in Table 17, and the area and capacity data for the reservoir, based upon a planetable survey made by the Division in 1931, are presented in Table 18.

TABLE 17

ESTIMATED RUN-OFF AVAILABLE FOR STORAGE AT PARKER CREEK RESERVOIR SITE

For the Period November 1 to April 15 Watershed Area 76 Square Miles

Season	Run-off in acre-feet	Season	Run-off in acre-feet
1918–1919	800	1925–1926	5,000
1919–1920	900	1926–1927	3,900
1920–1921	5,600	1927–1928	4,400
1921–1922	3,400	1928–1929	900
1922–1923	1,300	1929–1930	700
1923–1924	3,400	1930–1931	0
1924–1925	1,500		
		Average	2,450

NOTE.—Estimated quantities of water diverted to storage in Dorris Reservoir have been deducted.

TABLE 18

AREA AND CAPACITY OF PROPOSED PARKER CREEK RESERVOIR

Depth of water in feet (above stream bed at dam)	Area of water surface, in acres	Capacity in acre-feet
0	1	0
6	17	45
11	30	162
16	62	392
21	87	765
26	118	1,276
31	155	1,958
36	195	2,833
41	242	3,925

An analysis of the data reveals the following:

Average gross annual watershed yield	2,400 acre-feet
Storage required to develop average yield	8,500 acre-feet
Reservoir capacity	4,000 acre-feet
Average annual yield with reservoir capacity	1,400 acre-feet
Average annual reservoir losses (estimated)	1,000 acre-feet
Average annual safe delivery	400 acre-feet
Area to be served	1,700 acres
Average annual water supply per acre	0.24 acre-foot

The estimated construction cost of this project is shown below, assuming an earthfill dam at a unit overall cost of $1.50 per cubic yard of fill, including all spillway, outlet and appurtenant works:

Height of earthfill dam	50 feet
Yardage of dam (approximate)	70,000 cubic yards
Cost of dam	$105,000
Area of land inundated	300 acres
Capital cost per acre served	$62.00
Capital cost per acre-foot delivered	$263.00

It is apparent that the project is not feasible because of excessive cost.

Yankee Jim Reservoir Site.

The estimated run-off available for storage at this site is shown in Table 19, and the area and capacity data for the reservoir are presented in Table 20.

TABLE 19

ESTIMATED RUN-OFF AVAILABLE FOR STORAGE AT YANKEE JIM RESERVOIR SITE

For the Period November 1, to April 15—Watershed Area 15 Square Miles

Season	Run-off in acre-feet	Season	Run-off in acre-feet
1918–1919	110	1925–1926	2,170
1919–1920	160	1926–1927	1,690
1920–1921	2,560	1927–1928	1,960
1921–1922	1,430	1928–1929	170
1922–1923	340	1929–1930	20
1923–1924	1,430	1930–1931	0
1924–1925	430		
		Average	960

TABLE 20

AREA AND CAPACITY OF PROPOSED YANKEE JIM RESERVOIR

Depth of water in feet (above stream bed at dam)	Area of water surface, in acres	Capacity in acre-feet
0	0	0
6	42	107
11	183	671
16	252	1,759
21	303	3,149
26	354	4,793
31	396	6,668

An analysis of the data reveals the following:

Average gross annual watershed yield	960 acre-feet
Storage required to develop average yield	3,600 acre-feet
Reservoir capacity	6,700 acre-feet
Average annual reservoir losses (estimated)	960 acre-feet
Annual safe delivery	0

It appears that the holdover storage required to develop the small average annual yield necessitates such a large reservoir that the entire available supply would be consumed by reservoir losses, making the project infeasible. For similar reasons, the size of the reservoir and expenditure required to develop any part of the average annual run-off would be out of proportion to the safe annual yield produced.

Clear Lake Reservoir Site.

Clear Lake is a natural body of water on Mill Creek northeast of Jess Valley. The topography surrounding the lake is such as to afford an opportunity for additional storage by means of a dam at the outlet.

If the Jess Valley project is not constructed, Clear Lake could be enlarged to provide additional water after the haying season for about 1000 acres of land in Jess Valley, or for stock watering purposes in the South Fork Valley. It is estimated that storage capacity to the extent of about 1065 acre-feet could be provided by increasing the depth of water in the lake 30 feet.

The run-off available for storage in Clear Lake was estimated from the run-off records at the outlet of Jess Valley by a comparison of watersheds, as shown in Table 21.

TABLE 21

ESTIMATED RUN-OFF AVAILABLE FOR STORAGE AT CLEAR LAKE RESERVOIR SITE

For the Period November 1 to April 15—Watershed Area, 20 Square Miles

Season	Run-off in acre-feet	Season	Run-off in acre-feet
1918-1919	2,280	1925-1926	3,340
1919-1920	2,320	1926-1927	3,100
1920-1921	3,520	1927-1928	3,240
1921-1922	2,980	1928-1929	1,880
1922-1923	2,420	1929-1930	2,340
1923-1924	2,980	1930-1931	1,620
1924-1925	2,480	Average	2,650

An analysis of the data reveals the following:

Reservoir capacity	1,065 acre-feet
Average water surface area	51 acres
Average annual reservoir losses (estimated)	150 acre-feet
Average annual safe delivery	915 acre-feet
Area to be served (Jess Valley)	1,000 acres
Average annual water supply per acre	0.91 acre-foot

The estimated cost of this project is shown below, based upon the construction of an earthfill dam at a unit overall cost of $1.50 per cubic yard of fill, including all spillway, outlet and appurtenant works.

Height of earthfill dam	35 feet
Yardage of dam (approximate)	12,000 cubic yards
Cost of dam	$18,000
Capital cost per acre served	$18.00
Capital cost per acre-foot delivered	$19.70

These costs are excessive under present economic conditions.

Jess Valley Reservoir Site.

The Jess Valley Reservoir plan is presented in parallel with an alternate plan of storage in West Valley, either of which could be included in what is referred to as the "South Fork Project."

The South Fork Project would furnish a supplemental water supply for some 13,400 acres of lands in the South Fork Valley now under irrigation from the river. While no new lands have been considered in the financial analysis for the projects which have been made, it is believed that some 1300 acres of additional lands lying along the east side of South Fork Valley could ultimately be included if the Jess Valley plan is used, and that some 500 acres of such lands could ultimately be included if the West Valley plan is adopted. It is estimated that the gross annual irrigation water requirements for such new lands would be 2.40 acre-feet per acre, and this quantity has been considered in the water supply analyses.

As previously developed in Chapter IV, the average annual deficiency in net consumptive water supply demand for the present irrigated lands in the South Fork area is approximately 0.60 acre-foot per acre. Allowing for a 25 per cent conveyance loss, the average annual gross deficiency is about 0.80 acre-foot per acre, or a total of 10,700 acre-feet for the 13,400 acres now under irrigation.

Run-off. The estimated run-off available for storage in the proposed Jess Valley Reservoir is shown in Table 22. In this estimate only run-off occurring during the period between November 1st and

April 15th has been included. As a matter of fact, in average years some water will be available for storage until around the middle of May; hence the estimate is very conservative.

TABLE 22

ESTIMATED RUN-OFF AVAILABLE FOR STORAGE AT JESS VALLEY RESERVOIR SITE

For the Period November 1 to April 15—Watershed Area, 97 Square Miles

Season	Run-off in acre-feet	Season	Run-off in acre-feet
1918-1919	11,100	1925-1926	16,200
1919-1920	11,200	1926-1927	15,100
1920-1921	17,100	1927-1928	15,600
1921-1922	14,500	1928-1929	9,140
1922-1923	11,800	1929-1930	11,300
1923-1924	14,500	1930-1931	7,880
1924-1925	12,000		
		Average	12,900

It has been suggested in prior reports that the run-off from the upper portion of the Parsnip Creek watershed might be diverted through a reasonably short ditch into the Jess Valley drainage. Topographically this plan is feasible, and the tributary drainage area of Parsnip Creek would add 11 square miles to the 97 square miles naturally tributary to Jess Valley. Upon the assumption that the run-off per square mile from this additional area is the same as that for the Jess Valley watershed, Table 23 has been prepared, showing the estimated run-off from Parsnip Creek available for storage in Jess Valley during the 13 years from 1918 to 1931. If the Jess Valley Reservoir is to be confined to serving the South Fork lands now under irrigation, and the 1300 acres of new lands previously mentioned, Parsnip Creek water would not be needed.

TABLE 23

ESTIMATED RUN-OFF FROM PARSNIP CREEK AVAILABLE FOR STORAGE IN PROPOSED JESS VALLEY RESERVOIR

For the Period November 1 to April 15—Watershed Area, 11 Square Miles

Season	Run-off in acre-feet	Season	Run-off in acre-feet
1918-1919	1,210	1925-1926	1,770
1919-1920	1,230	1926-1927	1,640
1920-1921	1,860	1927-1928	1,720
1921-1922	1,580	1928-1929	997
1922-1923	1,280	1929-1930	1,240
1923-1924	1,580	1930-1931	859
1924-1925	1,320		
		Average	1,410

Physical Features of Site. Jess Valley is considered by geologists to be a pocket valley which has been formed by the differential uplift on the west side along a fault zone extending north and south. As evidenced by a well defined beachline around the valley, the area was once occupied by a lake of considerable depth, that has been drained by the erosion of its outlet to its present level. The lake was probably formed by a landslide at the outlet. The sediments of the valley floor

were apparently deposited prior to the draining of the lake, and are relatively impermeable.

The reservoir site was surveyed by the U. S. Reclamation Service, as reported in the 1915 Pit River Basin Report. Table 24 has been prepared from data contained in that report.

TABLE 24

AREA AND CAPACITY OF PROPOSED JESS VALLEY RESERVOIR

Depth of water in feet (above stream bed at dam)	Area of water surface, in acres	Capacity in acre-feet
0	0	0
2	810	810
12	1,730	13,500
22	2,160	33,000
32	2,460	56,000
42	2,700	81,000
52	2,880	110,000

Dam Site. The Jess Valley outlet, which is a narrow and comparatively level channel some 3000 feet long, offers several dam sites. The lower reach of the channel is confined by steep, high walls exposing beds of tuff and agglomerates overburdened by a thick capping of basalt. Debris from the cliffs has filled the canyon to a V-shaped gorge. Near the upper end of the outlet stretch the confining slopes are well rounded hills composed chiefly of tuff free from rock debris.

The landslide which formed the ancient Jess Lake occurred about 2000 feet below the upper end of the outlet stretch, and materials from this landslide occupy the outlet channel for a distance of nearly half a mile downstream.

There are three parallel faults running north and south across the outlet channel. The major fault, on the east, accounts for the western escarpment of Jess Valley, and passes directly across the upper end of the outlet channel at the point of confluence of Mill and Harvey Creeks. The western fault is situated approximately a mile below the mouth of Jess Valley and probably accounts for the termination at that point of the high basalt cap plateau which extends to the west. The intervening fault is approximately midway between the other two. No doubt the area between the east and west faults is a fault-zone approximately one mile wide, in which conditions favorable for the tremendous landslide which formed Jess Lake existed.

The alluvium deposits along the outlet stretch are of undetermined depth; although during recent years two attempts have been made by local people to determine the depth to solid material. At the upper end of the stretch a churn-drill rig penetrated 60 feet of finely bedded white or grey clay and mud, with a noticeable decrease in organic material below 10 feet. At the lower end of the reach a similar rig was only able to penetrate about 20 feet through large rock fragments.

The proposed dam site selected is located at the upper end of the outlet stretch, and is believed to be preferable to other sites on account of the more favorable conditions for a spillway through natural ground.

Type of Dam. The site is considered favorable for a homogeneous earthfill dam. A proposed plan of the dam and spillway is presented in Plate VII. Tuff excavated for the spillway would be used for the dam embankment. A concrete cut-off wall 2 feet thick would be required, extending to an estimated average depth of 30 feet below natural ground surface. A dam 28 feet high would be needed, and a crown width of 15 feet has been allowed, with 5 to 1 downstream and 4 to 1 upstream slopes. In view of the probable existence of relatively deep backwater against the lower face of the dam, both faces should be rip-rapped with the angular basalt fragments found a short distance below the site.

The outlet works would consist of a 4½-foot diameter concrete pipe, placed in an excavation through natural ground at the side of the dam. This culvert outlet would be equipped with a caterpillar type sluice gate at the upper end, with protecting screens and grizzlies, and operating on the slope of the dam. A gate tower would not be required. Ice thrust occurring at all stages of the reservoir must be taken into account in the design.

Spillway. The hills on the south side of the dam offer the better location for a straight channel spillway. Design has been made for a flood flow of 3340 second-feet, requiring a spillway 40 feet wide, about 3100 feet long, with a maximum depth of excavation of about 50 feet. Under maximum conditions the surface of the water in the reservoir would be 9.5 feet above the crest of the spillway, and an additional 1.5 feet should be allowed as freeboard.

The spillway would be lined with concrete 8 inches thick, reinforced with steel for temperature stresses.

Economic Aspects. The construction of the Jess Valley Reservoir would inundate more than 2200 acres of meadow hay lands, which is nearly twice the area of new lands that could be included under the project. The net result would be the loss of some 900 acres of producing lands. On the other hand, a very reliable supply would be provided for the complete irrigation of 13,400 acres of lands now irrigated with an insufficient supply, and for the 1300 acres of new lands.

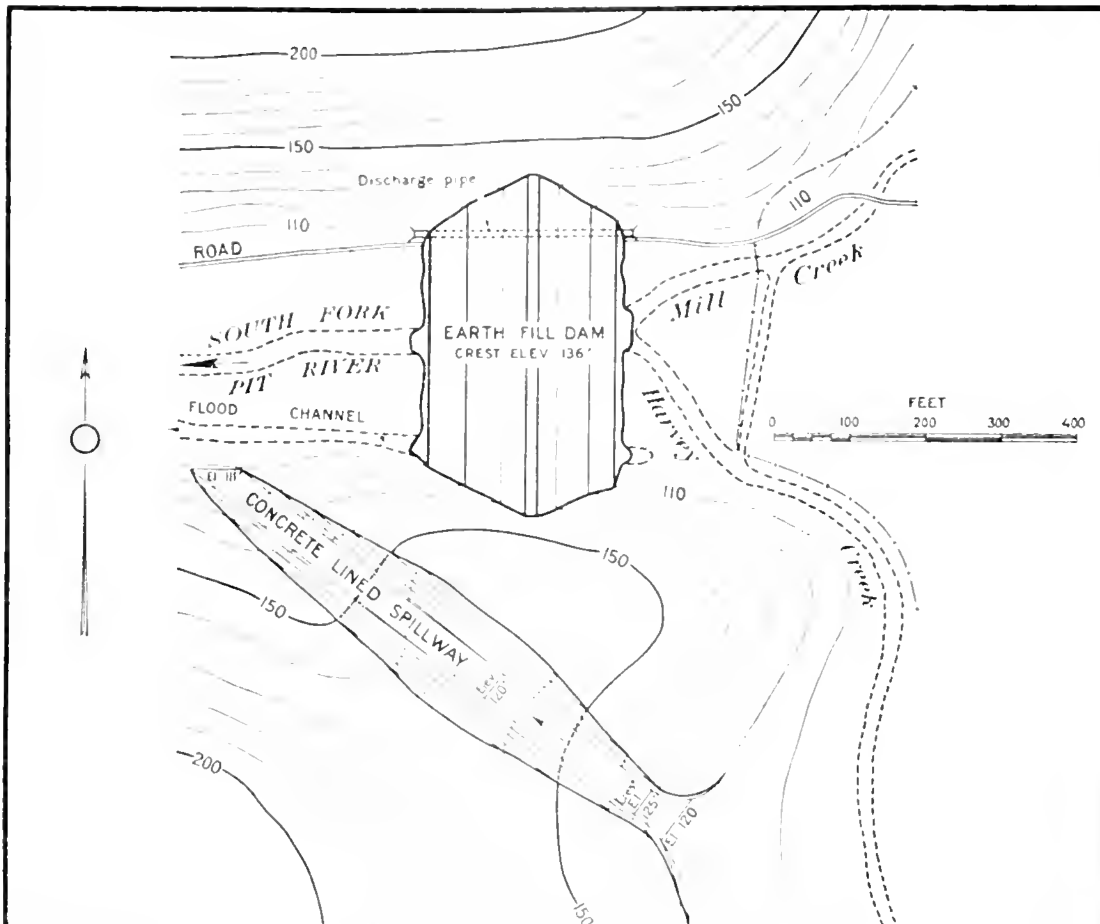
Analyses of the water supply, construction, and financial features of the Jess Valley phase of the South Fork Project are shown later on in this chapter in Tables 27, 28 and 29, in comparison with two alternative plans involving a reservoir in West Valley.

West Valley Reservoir Site.

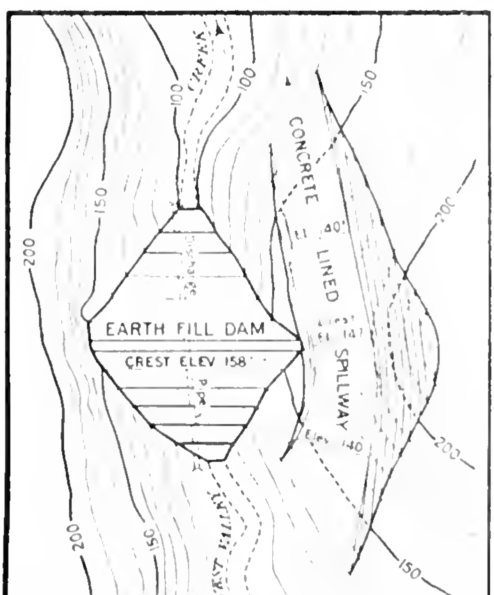
The run-off available for storage in the proposed West Valley Reservoir, from the present watershed, is insufficient to yield adequate supplemental water for the South Fork area; consequently additional water must be diverted into such storage either from the South Fork of Pit River or from Cedar Creek. With either of these additional sources the present 13,400 acres of irrigated land could be amply supplied throughout the irrigation season, and about 500 acres of new land could be provided for.

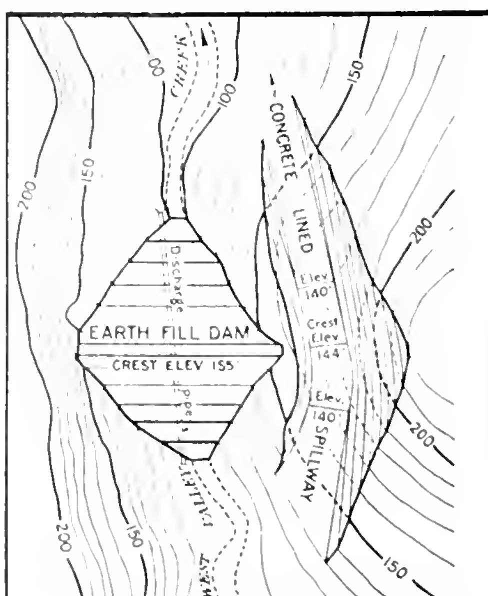
Run-off. The present drainage area above West Valley of 59 square miles yielded an estimated average run-off of 6990 acre-feet per annum during the 13 years from 1918 to 1931. By reverting the flow of Cedar Creek to its natural channel tributary to the West Valley

PLATE VII



JESS VALLEY DAM SITE
ON
SOUTH FORK OF PIT RIVER





For drainage area of 109 square miles

For drainage area of 59 square miles

WEST VALLEY DAM SITE
ON
WEST VALLEY CREEK

Creek, an additional 50 square miles can be added to the present watershed, making a total of 109 square miles tributary to the West Valley site. The estimated run-off available for storage from the present watershed and from the enlarged watershed are shown in Table 25. As in the case of Jess Valley, the run-off occurring after April 15th has not been included in the estimate.

TABLE 25

ESTIMATED RUN-OFF AVAILABLE FOR STORAGE AT WEST VALLEY RESERVOIR SITE

For the Period November 1 to April 15

Season	Run-off in acre-feet	
	Watershed area, 59 square miles	Watershed area, 109 square miles
1918–1919	6,180	11,200
1919–1920	6,200	11,400
1920–1921	9,150	16,900
1921–1922	7,850	14,500
1922–1923	6,430	11,900
1923–1924	7,850	14,500
1924–1925	6,550	12,100
1925–1926	8,670	16,000
1926–1927	8,090	14,900
1927–1928	8,450	15,600
1928–1929	4,740	8,720
1929–1930	6,150	11,300
1930–1931	4,610	8,500
Average	6,990	12,900

One plan to supplement the proposed West Valley storage is by the construction of a canal from the South Fork of Pit River to convey water available for storage in that source into the West Valley drainage. The route of a gravity canal from the South Fork was surveyed by the Division in 1931. Such a canal can be constructed with its intake at the Forest Service Public Camp, approximately 1 mile below the outlet of Jess Valley, and extending approximately $2\frac{3}{4}$ miles on a grade of 1 foot per 1000 feet, over a low saddle into the proposed reservoir. Owing to rock slides the upper 1700 feet of the canal must consist of some type of elevated flume. For cost estimates the use of a 5-foot diameter metal flume on timber supports, having a capacity of 30 second-feet, was assumed. It is estimated that this flume would have to be replaced after 20 years of use, and the cost estimate includes a sinking fund for that purpose. The remaining portion of the canal could be an earth ditch with the water line below cut. The excavation of the ditch would be in weathered tuff, containing rock fragments.

During a portion of the period from November 1 to April 15 the freezing weather may render it impossible to maintain the ditch. For that reason the water supply has been estimated on the basis of only 100 days of capacity flow of the ditch, giving a seasonal delivery of about 6000 acre-feet into the reservoir.

The only unfavorable feature of a South Fork supply ditch would be a rather high cost of maintenance and operation, due to its location on a north slope at a high elevation, making it subject to snow blockades and aggravated freezing weather effects. The construction of such a ditch could be eliminated from the project in the event that it might prove practical to acquire the right to revert the flow of upper Cedar

Creek from its present course into the Tule Lake Reservoir, back into the natural channel tributary to West Valley Creek. It is apparent from observations and from information given by local cattlemen that the Tule Lake Reservoir fills at least three or four feet deep following an average spring run-off. This depth of water represents an inflow in excess of 5000 acre-feet, which corroborates the estimated difference in run-off between the present and enlarged watersheds, as indicated in Table 25.

The alternate plan of reverting the flow of Cedar Creek would necessitate a somewhat greater hold-over storage capacity and a somewhat larger spillway, due to the fact that Cedar Creek shows very wide fluctuations in annual run-off, while the supply from the South Fork Ditch would be more or less constant.

Physical Features of Site. West Valley, like Jess Valley, is a pocket valley formed by differential uplift along fault zones on the sides of the valley in a north and south direction. The valley floor consists of alluvium partially deposited during the time a lake covered the valley and partially during the period since the outlet of the lake has eroded to its present elevation. The sedimentary deposits on the floor of the valley indicate a relative impermeability.

The reservoir site was surveyed by the U. S. Reclamation Service, and Table 26 has been prepared from unpublished maps of that survey, showing the area and capacity of the site.

TABLE 26

AREA AND CAPACITY OF PROPOSED WEST VALLEY RESERVOIR

Depth of water in feet (above stream bed at dam)	Area of water surface, in acres	Capacity in acre-feet
0	0	0
10	32	160
20	252	1,580
30	600	5,840
40	840	13,040
50	1,055	22,515

The West Valley site is elongated with a gently sloping floor, and the mean depth of water would be nearly twice that of the Jess Valley Reservoir. The comparatively small water surface of the West Valley Reservoir would make the annual evaporation loss relatively small.

Dam Site. The outlet channel of West Valley has been carved through a basalt and tuff formation to the present level, where the stream actually flows over bare solid rock in place. The west side is covered with the loose rock talus of the towering basalt cliffs on that side, but is constricted by a rounded promontory apparently consisting of tuff. The dam site selected is situated approximately 300 feet above the brink of the falls below the outlet of West Valley. There has been no exploration work done at this site so far as is known, but the narrowness of the gorge and the proximity to bed rock makes it appear favorable from surface indications.

The existence of the West Valley fault directly through the dam site complicates the problem of determining the probable geological conditions which would be encountered.

Type of Dam. A homogeneous earthfill dam, consisting of the graded tuff excavated from the spillway, is considered as the most economical type of structure for this site. Proposed plans for the dam and spillway under the two alternates for supplemental water supply are shown on Plate VII. Further exploration work may, however, change these plans. A concrete cut-off wall 2 feet thick, to an estimated average depth of 10 feet, would apparently be sufficient to provide a satisfactory percolation seal. A dam either 55 or 58 feet high would be required, depending on whether the South Fork or Cedar Creek is used as a supplemental supply, with a crown width of 15 feet and with $2\frac{1}{2}$ to 1 slopes upstream and 3 to 1 slopes downstream. There would be no backwater against the lower face of the dam, so only the upper face need be rip-rapped. Basalt rock fragments from the adjacent cliffs could be used for this purpose.

The outlet works would consist of a $4\frac{1}{2}$ foot diameter concrete pipe placed in an excavation in natural ground under the dam on one side of the present stream channel. At the upper end, this culvert outlet would be equipped with a caterpillar type sluice gate operated on the slope of the dam, with protecting screens and grizzlies. Ice thrust occurring at all stages of the reservoir must be taken into account in the design.

Spillway. The spillway requirement for this site is estimated at 5500 second-feet for the 109 square mile drainage area including the Cedar Creek reversion, and 3200 second-feet for the present 59 square mile drainage area. To handle these amounts of water a large straight channel spillway could be constructed through the abutment hill on the east side of the dam. The computed width of the spillway for the larger flow is 80 feet and for the smaller flow 50 feet, which widths would pass the respective floods with an effective head (depth of reservoir water surface above spillway crest) of 8.5 feet. An additional 2.5 feet in depth has been allowed as freeboard.

The excavation yardage for the spillway would be considerably in excess of the yardage required to construct the dam. Also, it is estimated that there would be some unavoidable waste of rock embedded in the east abutment that could not be safely put into the section of the dam.

The spillway would be lined with concrete 8 inches thick, reinforced with steel for temperature stresses.

Economic Aspects. The area of the meadow lands in West Valley which would be inundated is comparatively small and there is apparently no question but that the benefit gained by increasing crops in the South Fork Valley would more than compensate for the loss of the West Valley lands.

The water supply, construction and financial features of the Jess Valley and of the two West Valley plans are compared in Tables 27, 28, and 29, respectively. The various items of these plans involving dam foundation conditions and financing costs can be definitely determined only by a more detailed investigation and study of these aspects by parties who may be interested in consummating the project. The costs of the necessary reservoir sites, rights of way, water rights, etc., have not been included in the financial analyses, as it was not considered that these matters were within the scope of this investigation.

These details must also be investigated by interested parties before a final conclusion as to the most favorable of the three plans can be reached.

TABLE 27

COMPARATIVE WATER SUPPLY ANALYSES OF PROPOSED JESS VALLEY AND WEST VALLEY RESERVOIRS

	Jess Valley	West Valley	
		South Fork Ditch	Reversion of Cedar Creek
Location of dam	Upper site, NW¼ of NW¼ Sec. 11, T. 39 N., R. 13 E.	At outlet, NW¼ Sec. 18, T. 39 N., R. 14 E.	At outlet NW¼ Sec 18, T. 39 N., R. 14 E.
Tributary drainage area, in square miles	97	59*	109
Spillway requirements for flood, 1 in 1,000 years, in second-feet	3,340	3,200	5,500
Required storage capacity in acre-feet	23,000	16,600	19,500
Storage depth, in feet	17	44	47
Height of dam, in feet	28	55	58
Maximum water surface area, in acres	2,200	950	1,000
Mean depth of water, in feet	10.4	17.5	19.5
Outlet capacity, in second-feet	300	300	300
Gross annual reservoir yield, in acre-feet	13,200	13,100x	13,200
Amount of deficiency, 1 in 11 years, in acre-feet	2,000	3,000	5,000
Estimated seasonal reservoir losses, in acre-feet	4,800	2,500	2,500
Estimated gain from irrigated lands to be inundated, in acre-feet per season	5,500	1,200	1,200
Annual safe delivery of storage water, in acre-feet	13,900	11,800	11,900
Acreage to be served—			
Present irrigated land	13,400	13,400	13,400
New land	1,300	500	500
Estimated net consumption per acre, in acre-feet per season—			
On present irrigated land	0.60	0.60	0.60
On new land	1.80	1.80	1.80
Estimated conveyance requirements per acre, in acre-feet per season—			
For present irrigated land	0.20	0.20	0.20
For new land	0.60	0.60	0.60
Gross reservoir supply per acre, in acre-feet per season—			
For present irrigated land	0.80	0.80	0.80
For new land	2.40	2.40	2.40

*Not inclusive of drainage area tributary to South Fork supply ditch.
x Includes 6,000 acre-feet per annum from South Fork supply ditch.

TABLE 28

COMPARATIVE CONSTRUCTION DETAILS AND COSTS FOR PROPOSED JESS VALLEY AND WEST VALLEY RESERVOIRS

	Jess Valley	West Valley	
		South Fork Ditch	Reversion of Cedar Creek
Construction Details			
Spillway (excavation to be used for dam embankment)—			
Length of crest, in feet	40	50	80
Effective head over crest, in feet	9.5	8.5	8.5
Residual freeboard, in feet	1.5	2.5	2.5
Total excavation, cubic yards	62,300	42,200	55,800
Placed in dam, cubic yards	53,900	37,400	44,000
Wasted, cubic yards	8,400	4,800	11,800
Spillway lining—8-inch concrete—			
Area of lining, in square feet	24,000	22,500	30,000
Concrete, cubic yards	593	556	741
Dam embankment, earthfill, cubic yards—	53,900	34,000	40,000
Upstream slope	4 to 1	2½ to 1	2½ to 1
Downstream slope	5 to 1	3 to 1	3 to 1
Crown width, in feet	15	15	15
Crest length, in feet	450	270	280
Stripping dam site, cubic yards	9,000	12,000	12,000
Dam cut-off, estimated—			
Dry excavation, cubic yards	900	250	250
Wet excavation, cubic yards	500	50	50
Concrete core, cubic yards	1,000	200	200
Outlet structure—			
Excavation, cubic yards	240	480	480
Diameter of outlet, in feet	4.5	4.5	4.5
Concrete in culvert, foundation and head walls, cubic yards	135	263	263
Rip-rap, rock 1 foot thick	Both faces	Upper face	Upper face
Face area, in square yards	11,000	2,800	2,800
Supply ditch from South Fork—			
Metal flume, 5 foot dia., length in feet	----	1,700	----
Earth ditch excavation, cubic yards	----	20,000	----
Cost Estimate[1]			
Stripping dam site (a)	$2,250	$6,000	$6,000
Dam cut-off[2]—			
Dry excavation (b)	2,700	375	375
Wet excavation (c)	3,750	250	250
Concrete core, at $13.00 per cubic yard	13,000	2,600	2,600
Outlet structure—			
Excavation (d)	240	720	720
Concrete culvert, at $25.00 per cubic yard	3,375	6,575	6,575
Gate, frame and screen	3,500	3,500	3,500
Spillway and dam embankment—			
Excavation from spillway placed in dam, at $0.60 per cubic yard	32,340	22,440	26,400
Excavation wasted, at $0.30 per cubic yard	2,520	1,440	3,540
Concrete lining for spillway, at $16.00 per cubic yard	9,488	8,896	11,856
Rip-rap facing (rock 1 foot thick) at $1.25 per cubic yard	4,584	1,168	1,168
Road relocation	3,750	0	0
Supply ditch from South Fork—			
Metal flume, 5 foot dia., 1,700 feet at $10.00	----	17,000	----
Excavation earth ditch at $0.35 per cubic yard	----	7,000	----
Diversion dam	----	1,000	----
Engineering and contingencies at 25%	20,374	19,741	15,746
Interest during construction at 6% compounded semi-annually—			
For first year work of stripping, cut-off, outlet, engineering and contingencies (for 1½ years)	2,934	1,915	1,915
For second year work of completing structure (1 year)	4,277	4,754	3,537
Total cost of construction	$109,082	$105,374	$84,182

[1] Unit construction prices are on the same basis as used in other reports of the Division of Water Resources dealing with the Central Valley Project of California. It is known, however, that even during the period of high prices in the 1920's dams were built by private interests in Modoc County for much less.

(a) Jess Valley $0.25 per cubic yard, West Valley $0.50 per cubic yard.
(b) Jess Valley $3.00 per cubic yard, West Valley $1.50 per cubic yard.
(c) Jess Valley $7.50 per cubic yard, West Valley $5.00 per cubic yard.
(d) Jess Valley $1.00 per cubic yard, West Valley $1.50 per cubic yard.

[2] While detail investigation of foundation at the dam sites has not been made, there are no surface indications that difficulties will be met.

TABLE 29

COMPARATIVE FINANCIAL ANALYSES OF PROPOSED JESS VALLEY AND WEST VALLEY RESERVOIRS ON BASIS OF CONSTRUCTION COSTS

	Jess Valley	West Valley	
		South Fork ditch	Reversion of Cedar Creek
Total cost of construction	$109,082	$105,374	$84,142
Total annual amortization charge for 20 year period at 6 per cent interest on construction costs and with 4 per cent interest on sinking fund	$10,208	$9,861	$7,874
Annual amortization charge per acre served[1]	$0.76	$0.74	$0.59

[1] Entire cost of project apportioned to present irrigated land only.

It will be noted that the above annual amortization charge does not include interest on cost of rights of way and of water rights. The cost of rights of way for the Jess Valley reservoir would be high. The additional water made available by either of the reservoirs would increase the average hay crop and give additional income from fall pasture. At the average price of hay and pasture during the ten years preceding 1932 this added income would be sufficient to pay all added costs, including interest on any reasonable price for rights of way and water rights, and yield a fair profit besides.

Bayley Reservoir Enlargement.

The present Bayley Reservoir is situated on Crooks Canyon stream on the lower portion of the rolling plateau lying between the southern end of South Fork Valley and the summits of the Adin Mountains. It has been proposed to construct a new dam a few hundred feet downstream from the present dam, to impound approximately 9000 acre-feet.

The estimated run-off available for storage in the Bayley Reservoir, as derived from records obtained from the stream gaging station at the mouth of Crooks Canyon extended by a comparison with the precipitation records at Alturas, is indicated in Table 30.

An analysis of the data shows the following:

Average gross annual watershed yield	2,470 acre-feet
Storage required to develop average yield	8,800 acre-feet
Average annual reservoir losses (estimated)	610 acre-feet
Average annual safe delivery	1,860 acre-feet

TABLE 30

ESTIMATED RUN-OFF AVAILABLE FOR STORAGE AT BAYLEY RESERVOIR

For the Period November 1 to April 15 Watershed Area, 33 Square Miles

Season	Run-off in acre-feet	Season	Run-off in acre-feet
1904-05	2,900	1918-19	2,520
1905-06	3,660	1919-20	1,990
1906-07	5,350	1920-21	2,500
1907-08	880	1921-22	2,890
1908-09	3,380	1922-23	390
1909-10	2,460	1923-24	1,090
1910-11	4,160	1924-25	2,610
1911-12	1,800	1925-26	1,720
1912-13	1,650	1926-27	3,960
1913-14	2,690	1927-28	3,200
1914-15	1,900	1928-29	1,340
1915-16	2,590	1929-30	2,240
1916-17	4,840	1930-31	400
1917-18	1,760		
		Average	2,470

The cost of a new dam at the proposed site below the present Bayley dam appears to be too great for the amount of water available. On the basis of $1.50 per cubic yard of dam embankment, as covering the overall costs including appurtenant works, the estimated cost of a dam to fully develop the average net safe annual delivery is approximately $150,000. This would represent about $81 per acre-foot of yield, which is excessive.

It is thought that the enlargement of the present Bayley Reservoir would be the most economical plan of further conservation on this stream. The present capacity of the reservoir, estimated at 900 acre-feet, gave an annual safe delivery of about 525 acre-feet during the recent critical period. If the dam were raised to the maximum height afforded by the topography of the site, giving a capacity of about 2500 acre-feet, an annual safe delivery of approximately 1100 acre-feet could be obtained. With an enlargement to a capacity of 1500 acre-feet, an annual safe delivery of about 790 acre-feet could be obtained.

The area that could be most economically served with additional water from Bayley Reservoir comprises about 2000 acres lying contiguous to the West Side Canal in the South Fork Valley, but sufficient water for this entire acreage would not be available.

No data are available from which a cost estimate of an enlargement of the present Bayley Reservoir could be made.

Big Sage Reservoir.

Since its completion in 1921, the Big Sage Reservoir has been the major factor in furnishing a complete water supply to all of the irrigated lands along Pit River in Hot Springs Valley. During ordinary years water is released for irrigation only during the summer and fall months, but during the recent dry years it has been necessary to release water as early as April to supplement the supply from Pit River.

It has been suggested that the watershed yields sufficient water to irrigate a considerably larger area than is at present irrigated from the reservoir. The following data and analysis, however, indicates that such is not the case.

The run-off available for storage in the Big Sage Reservoir has been estimated for twenty-seven years by comparing the actual measured run-off since 1921 with the precipitation records at Alturas. The data are shown in Table 31.

TABLE 31

ESTIMATED RUN-OFF AVAILABLE FOR STORAGE AT BIG SAGE RESERVOIR

For the Period November 1 to April 15   Watershed Area, 107 Square Miles

Season	Run-off in acre-feet	Season	Run-off in acre-feet
1903–04	49,200	1917–18	10,400
1904–05	18,500	1918–19	15,900
1905–06	23,600	1919–20	12,200
1906–07	36,300	1920–21	15,700
1907–08	4,400	1921–22	26,000
1908–09	21,900	1922–23	8,150
1909–10	15,600	1923–24	5,200
1910–11	27,100	1924–25	15,000
1911–12	10,500	1925–26	17,000
1912–13	9,900	1926–27	10,500
1913–14	17,100	1927–28	17,900
1914–15	11,700	1928–29	13,400
1915–16	16,400	1929–30	13,200
1916–17	32,400	1930–31	1,070
		Average	17,300

Run-off estimated 1903 to 1921.
Run-off measured 1922 to 1931.

The area and capacity data for the reservoir, obtained in part from observations made by the Division and in part from information supplied by the Hot Spring Valley Irrigation District, are shown in Table 32.

TABLE 32

AREA AND CAPACITY OF BIG SAGE RESERVOIR

Reservoir gage in feet	Area in acres	Capacity in acre-feet
5	20	670
10	860	3,650
15	1,630	10,550
20	2,450	21,300
25	3,340	35,400
30	4,280	53,700
35	5,270	77,000

With the present storage capacity of 77,000 acre-feet, an analysis of the data shows the following:

For 27-year Period—

Average gross annual watershed yield	17,300 acre-feet
Average annual hold-over	37,100 acre-feet
Average annual storage	54,400 acre-feet
Total amount of spillage	0
Deficiency, once in 27 years, of	7,000 acre-feet
Average water surface area	4,700 acres
Average annual reservoir loss (estimated)	11,000 acre-feet
Net annual safe delivery	3,270 acre-feet

For 10-year Period (1922 to 1931)—

Average gross annual watershed yield	12,700 acre-feet
Average annual hold-over	8,770 acre-feet
Average annual storage	21,500 acre-feet
Total amount of spillage	0
Deficiency, once in 10 years, of	450 acre-feet
Average water surface area	2,400 acres
Average annual reservoir loss (estimated)	7,250 acre-feet
Net annual safe delivery	5,480 acre-feet

Allen Camp Reservoir Site.

The site which is proposed for a reservoir for the benefit of Big Valley is situated on the main river at what is known as "Allen Camp." Such a reservoir would round out the water requirements of the existing 12,000 acres of land in the area irrigated from the river, and would also provide for the irrigation of some 300 acres of new land.

The present irrigated area includes the lands along Pit River above Lookout which are classed as subirrigated, similar subirrigated lands east of Lookout, the lower reaches of Ash Creek Swamp that receive flood water from Pit River through the sloughs east of Lookout, the Oilar (Gooch) Swamp meadow, all of the meadows along Pit River on the bottom lands, and all of the lands southeast of Bieber that are readily irrigated through the Babcock ditch system.

New lands along the river bottoms can readily be irrigated by the construction of additional check dams in the sloughs, and new lands lying southeast of Bieber, in the Juniper Creek district, can be irrigated by enlarging and extending the Babcock ditch system. The use on the lands along Pit River above Lookout which are at present subirrigated by infiltration of back water created by the Lookout Dam, can be increased by either surface irrigation afforded by pumping, or by raising the water with additional river dams above the Lookout Dam.

As developed in Chapter IV, the average annual deficiency in net consumptive use for Big Valley along Pit River is approximately 0.80 acre-foot per acre. Allowing for a 20 per cent conveyance loss, the average annual gross deficiency is about 1.00 acre-foot per acre, or a total of about 12,000 acre-feet for the 12,000 acres presently irrigated. It is estimated that the annual gross water requirements for the new lands susceptible to irrigation in Big Valley would be approximately 3.00 acre-feet per acre.

Run-off. The estimated run-off available for storage in the proposed Allen Camp Reservoir is shown in Table 33. In this estimate, the amount of water which it is proposed to store for the South Fork project has been deducted. It will be noted that the measured run-off during the lowest year of record, 1931, was in excess of the storage required; consequently no additional reservoir capacity is necessary to provide hold-over storage.

TABLE 33

ESTIMATED RUN-OFF AVAILABLE FOR STORAGE AT ALLEN CAMP RESERVOIR SITE

For the Period November 1 to April 15 Watershed Area, 1,444 Square Miles

Season	Run-off in acre-feet	Season	Run-off in acre-feet
1918–19	98,900	1925–26	57,400
1919–20	89,800	1926–27	154,900
1920–21	176,900	1927–28	155,400
1921–22	128,500	1928–29	28,660
1922–23	49,400	1929–30	72,100
1923–24	32,700	1930–31	17,200
1924–25	78,000		
		Average	87,700

Physical Features of Site. In passing through the Adin Mountains between Hot Springs Valley and Big Valley, Pit River is confined

to relatively narrow canyons which widen in the lower reaches above the vicinity of Gouger Neck. The Allen Camp Reservoir site is located at the widest part of the canyon below the Stonecoal Valley county bridge.

The site was surveyed by Messrs. A. M. Green and Max Green and the map of that survey was furnished to the Division. The area and capacity data for the proposed reservoir have been computed from this map and are presented in Table 34.

TABLE 34

AREA AND CAPACITY OF PROPOSED ALLEN CAMP RESERVOIR

Depth of water in feet (above stream bed at dam)	Area of water surface, in acres	Capacity, in acre-feet
0	0	0
5	88	440
15	304	2,400
25	462	6,230
35	646	11,760
45	814	19,060
55	1,041	28,300
65	1,370	40,400
75	1,790	36,200
85	2,290	76,600

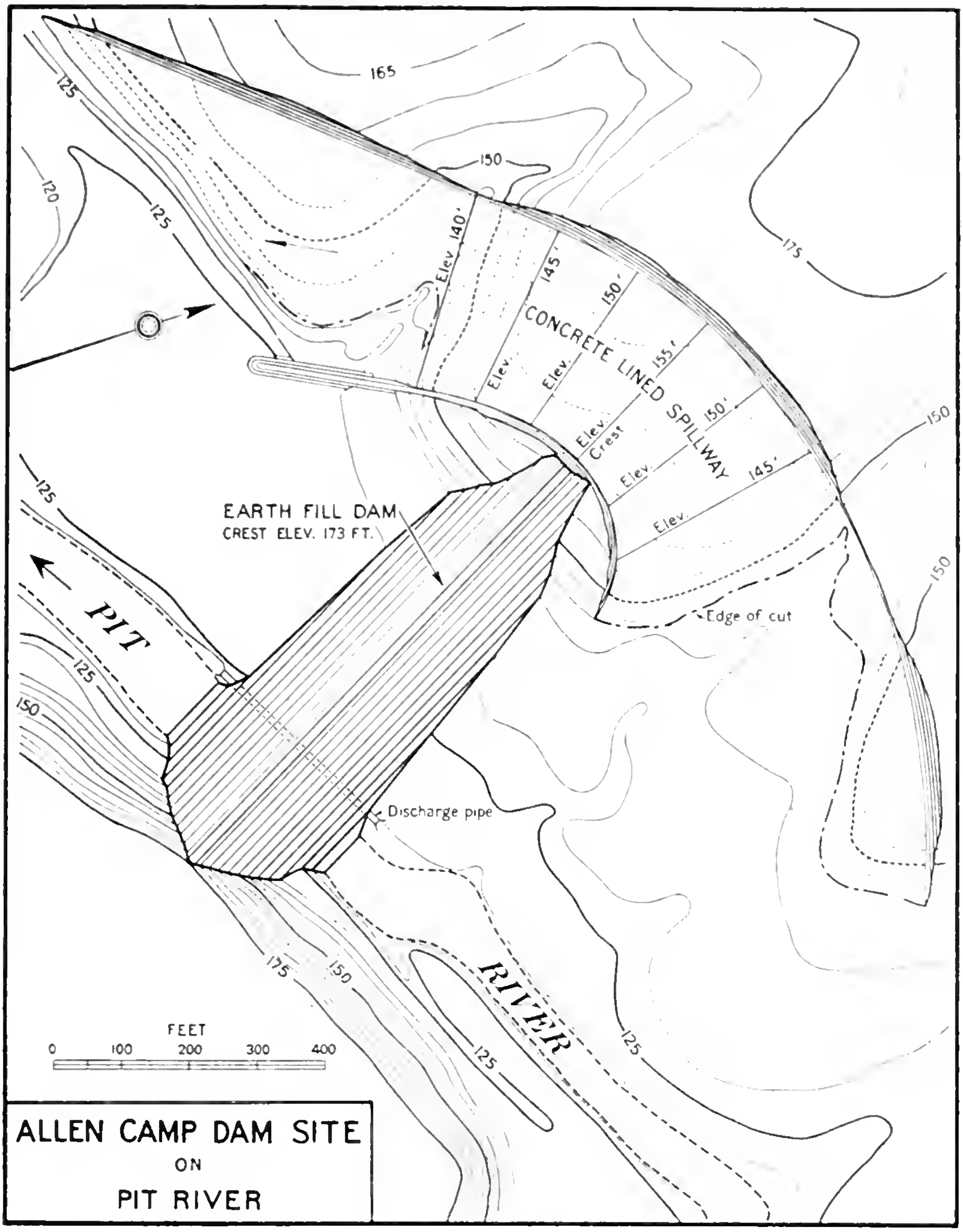
Dam Site. The point which has been selected as a favorable dam site is located in the W½ of NE¼ Sec. 30, T. 41 N., R. 8 E., above Lookout and about 300 feet downstream from a dilapidated group of ranch buildings locally known as "Allen's Camp." This site was chosen primarily because it offers the only possibility for a spillway of ample capacity to handle the anticipated flood, along the entire stretch of river under consideration.

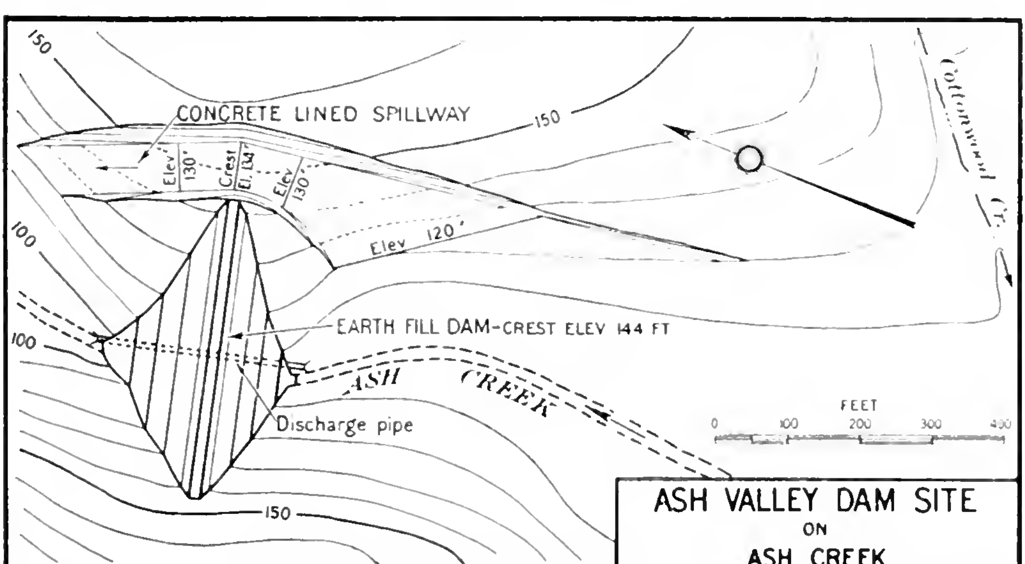
The south abutment is a steep uniformly sloping hill, and the north abutment is the well rounded rim of a broad undulated terrace with a gentle rise toward the north away from the river, but with deeply eroded washes or gullies cut down through the terrace. Apparently the terrace consists of deep laid tuff overburdened by a shallow covering of soil and rock fragments. The depth of the alluvium and detrital material in the Pit River channel between abutments is unknown, but a depth in excess of 25 feet is to be expected before underlying solid strata of tuff will be reached.

Type of Dam. The site is considered favorable for a homogeneous earthfill dam, with the material obtained from the spillway excavation. A proposed plan of the dam and spillway is presented in Plate VIII. A concrete cut-off wall 2 feet thick should probably extend down at least 28 feet below the present ground surface. The dam would be 58 feet high, with 2½ to 1 slopes on both faces and with a 15-foot width of crown. High back-water conditions will probably occur, making it necessary to place a loose rip-rap over both faces. Local fragmented lava rock is well suited for this purpose.

The outlet works would consist of a 6-foot diameter concrete pipe, with 500 second-feet capacity placed under the south end of the dam embankment in a cut in natural material. It would be equipped with a caterpillar type sluice gate at the upper end, operating on the slope

PLATE VIII


165
150
175
125
120
Elev. 140'
145'
150'
155'
150'
145'
Elev.
Crest
CONCRETE LINED SPILLWAY
EARTH FILL DAM
CREST ELEV. 173 FT.
Edge of cut
Discharge pipe
PIT
RIVER
FEET
0
100
200
300
400
ALLEN CAMP DAM SITE
ON
PIT RIVER


150
100
CONCRETE LINED SPILLWAY
Elev. 130'
Crest El. 134'
Elev. 130'
Elev. 120'
Cottonwood Cr.
EARTH FILL DAM-CREST ELEV. 144 FT
Discharge pipe
ASH
CREEK
FEET
0
100
200
300
400
ASH VALLEY DAM SITE
ON
ASH CREEK

of the dam, thereby eliminating the necessity for a gate tower. The gate should be protected by a trash-rack and grizzly. Ice thrust must be considered in the design.

Spillway. The estimated maximum flood flow at the dam site is 50,000 second feet. The terrace formation on the north bank offers an opportunity to excavate a broad, comparatively shallow spillway, taking advantage of two adjacent gullies situated on either side of the north abutment. The tuffaceous materials to be excavated for the spillway are considered satisfactory for the earthfill embankment of the dam. The size and shape of the spillway were determined with the view of providing ample yardage for the dam from the spillway excavation. The crest length of the spillway is 280 feet, and the water level in the reservoir would be 16 feet above the elevation of the crest with a discharge of 50,000 second-feet. The freeboard would be 2 feet.

The spillway would be lined with 8-inch thick concrete over the approach and for a distance of at least 300 feet below the crest.

Analysis of Project. The net reservoir yield after deducting evaporation losses would be 13,000 acre-feet with no deficiencies in any year. Twelve thousand acres of presently irrigated land would be supplied with a supplemental supply of 1 acre-foot per acre and 300 acres of new land with 3 acre-feet per acre, giving a net additional supply of 0.8 acre-foot per acre and 2.25 acre-feet per acre, respectively, on the land.

Estimated costs are as follows:[1]

Stripping dam site	10,000 cu. yds. at $0.25		$2,500
Dam cut-off[2]			
Dry excavation	1,500 cu. yds. at 3.00	$4,500	
Wet excavation	1,000 cu. yds. at 7.50	7,500	
Concrete core	1,700 cu. yds. at 12.50	21,250	33,250
Outlet structure			
Excavation	900 cu. yds. at 1.00	900	
Concrete	300 cu. yds. at 24.50	7,350	
Gate, frame and screen		4,000	12,250
Spillway			
Excavation placed in dam	160,000 cu. yds. at 0.50	80,000	
Concrete lining	2,963 cu. yds. at 15.50	45,926	125,926
Dam embankment (no borrowed fill)			0
Rip-rap facing	7,200 cu. yds. at 1.25		9,000
Road relocation			5,000
	Total		$187,926
Engineering and contingencies at 25%			46,982
Interest during construction at 6% compounded semiannually			
For first year work of stripping, cut-off, outlet, engineering and contingencies (for 1½ years)		$5,100	
For second year work of completing structure		10,957	16,057
Total cost of construction			$250,965

[1] Unit construction prices are on the same basis as used in other reports of the Division of Water Resources dealing with the Central Valley Project of California. It is known, however, that even during the period of high prices in the 1920's dams were built by private interests in Modoc County for much less.

[2] While detail investigation of foundation at the dam site has not been made, there are no surface indications that difficulties will be met.

It will be noted that cost of right of way is not included in the above. Exclusive of interest on this, the annual amortization charge at 6% interest and retirement of debt in 20 years, would be $1.96 per acre served. The increased hay crop and fall pasture made possible by the additional water, at the average prices received for hay and pasture during the ten years preceding 1932, would be sufficient to pay the above amortization charge and interest on any reasonable price for right of way, and in addition yield a profit.

The Allen Camp Reservoir site includes about 730 acres, a small portion of which consists of bottom lands that are being farmed. There are no irrigated lands in the area that would be inundated. The cost of the reservoir site should therefore be comparatively small, and the feasibility of the project may be largely determined from the construction costs.

Ash Valley Reservoir Site.

A reservoir in Ash Valley would provide a full season water supply for the lands in Big Valley now irrigated from Ash Creek, comprising approximately 9000 acres, and would also furnish water for the irrigation of about 800 acres of new land.

The present irrigated area includes all of the lands downstream from Adin to Pit River, and also the lands which are irrigated from the C. W. Clark (Snell) ditch. It is believed that a high-line ditch, heading on Ash Creek where it enters Round Valley, could be constructed around the east and north sides of Round Valley to include approximately 600 acres of new agricultural land under irrigation. Also, the Clark ditch could be enlarged and extended to serve several hundred acres of good agricultural lands southeast of Bieber, in the Juniper Creek district. With a somewhat larger reservoir than the one proposed, a ditch heading on Ash Creek at its confluence with Willow Creek could be constructed on a flat grade to cover more than 2000 acres of agricultural lands lying on the lower benches east and southeast of Bieber.

The net consumptive water requirements of the lands in the Ash Creek area were found to be practically the same as for those in the Pit River area in Big Valley. The average annual deficiency in net consumptive use on the presently irrigated lands is approximately 0.80 acre-foot per acre. With a 20 per cent allowance for conveyance losses, the average annual gross deficiency is about 1.00 acre-foot per acre, or a total of about 9000 acre-feet for the lands now irrigated along lower Ash Creek. It is estimated that the annual gross water requirements for the new lands susceptible to irrigation from Ash Creek would be approximately 3.00 acre-feet per acre.

Run-off. The estimated run-off available for storage in the proposed Ash Valley Reservoir is shown in Table 35. The flood run-off of Ash Creek occurs largely during the nonirrigating period, and a sub-

stantial winter flow is supplied from perennial springs in the reservoir site; hence the water supply available for storage would be quite reliable provided the flows of the springs would not be materially affected by the reservoir.

TABLE 35

ESTIMATED RUN-OFF AVAILABLE FOR STORAGE AT ASH VALLEY RESERVOIR SITE

For the Period November 1 to April 15—Watershed Area, 119 Square Miles

Season	Run-off in acre-feet	Season	Run-off in acre-feet
1918-19	15,000	1925-26	14 400
1919-20	15.400	1926-27	26,000
1920-21	31,900	1927-28	29,000
1921-22	24,300	1928-29	6.620
1922-23	11,300	1929-30	15,800
1923-24	10,500	1930-31	5,940
1924-25	16,200		
		Average	17,100

There are numerous springs on the floor of Ash Valley, the flow from which all combine to form the normal flow of Ash Creek as it emerges from the valley. These springs are simply holes in the meadows in which water stands at the plant root level, and which yield from a trace of water to as much as three second-feet. The open holes vary from merely small seeps to ponds 40 feet in diameter. The meadows surrounding the springs are completely saturated and quake under foot. There are many acres of the bottom lands in Ash Valley which apparently are floating on large subterranean ponds by virtue of the compact entanglement of grass roots and sod. The question arises as to whether or not the exuding flows from these springs would cease or greatly diminish if inundated by the proposed reservoir. If so, this project would be infeasible because the flows from the perennial springs would provide a large portion of the storage water during the drier years, as well as the present irrigation season supply.

The constancy of the springs, regardless of dry years and seasonal climatic variations, indicates that their sources are deep seated. Such being the case, it is probable that the raising of the pressure by an additional 35 or 40 feet would not materially affect the flows. A further study of this matter would have to be made, however, before the project could be finally approved.

Physical Features of Site. Ash Valley is a broad expanse of level plains surrounded by mountains which converge at the north to form a narrow canyon, through which Ash Creek flows out of the valley. The valley floor has probably been formed by sediments which were deposited under the waters of an ancient lake covering the area. The proposed reservoir would cover only a relatively small portion of the valley floor, confined to the bottom lands near the outlet.

A survey of the Ash Valley reservoir site was made by the State Engineering Department in 1922, and the area and capacity data for the reservoir, as obtained from that survey, are presented in Table 36.

TABLE 36

AREA AND CAPACITY OF PROPOSED ASH VALLEY RESERVOIR

Depth of water in feet (above stream bed at dam)	Area of water surface, in acres	Capacity in acre-feet
0	0	0
5	30	100
15	160	1,000
25	560	4,000
35	1,820	16,200
45	3,870	39,000
55	6,040	88,000
65	7,200	166,000
75	7,950	236,000
85	8,560	314,000

Dam Site. The outlet channel of Ash Valley, in its upper reaches, is confined by well rounded low hills; below these the canyon walls rise to considerable heights. The constricting hills at the outlet offer an excellent location for a spillway around the end of the dam. Based upon the results of the 1922 survey, two dam sites were selected for preliminary investigation. In this report the upper of these two sites has been chosen as the most favorable.

This site is located in the SW¼ Sec. 18, T. 38 N., R. 11 E., approximately 400 feet below the point of confluence of Cottonwood Creek and Ash Creek, at a narrow section caused by a constricting hill jutting into the channel from the east. The abutments at this location apparently consist of tuff with an overburden of soil and lava rock fragments. The depth of the alluvium and detrital materials is unknown, but appearances indicate that a solid tuffaceous material may be reached within a few feet of the present stream channel level.

Type of Dam. The site is considered favorable for a homogeneous earthfill dam. A proposed plan of the dam and spillway is shown on Plate VIII. The tuffaceous material excavated from the spillway is suitable for the dam embankment, but some borrow will also be required. The concrete cut-off wall, 2 feet thick, would extend down to an estimated average depth of 17 feet below present ground surface. The dam would be 44 feet high, and would be built with a 2½ to 1 upstream slope, a 3 to 1 downstream slope, and a 15-foot width of crown. There is probability of partial back-water conditions below the dam; hence rock rip-rap should be placed on both faces. Basalt rock fragments are available for this purpose, at the site.

The outlet works would consist of a 4½-foot diameter concrete pipe, with a capacity of 300 second-feet, placed in excavation on the foot of the slopes of the abutments. Control equipment would consist of a caterpillar type gate, operated on the upstream face of the dam behind a suitable trash screen and grizzly. Ice thrust conditions must be designed for.

Spillway. The abutment on the east bank offers a good location for a straight channel spillway. The expected maximum flood flow intensity is 4700 second-feet, and to carry this a spillway channel 65 feet wide would be required. This width would handle such a flow with an effective head (depth of reservoir water above spillway crest) of 8.5 feet. An additional 1.5 feet has been allowed for freeboard.

The spillway would be lined with 8-inch thick concrete, reinforced with steel for temperature stresses.

Analysis of Project. The net reservoir yield after deducting evaporation losses would be 11,500 acre-feet, with a deficiency of 2500 acre-feet once in eleven years. Nine thousand acres of presently irrigated land would be supplied with a supplemental supply of 1 acre-foot per acre, and 800 acres of new land with 3 acre-feet per acre, giving a net of 0.8 acre-foot per acre and 2.25 acre-feet per acre, respectively, on the land.

Estimated costs are as follows:[1]

Stripping dam site	6,000 cu. yds. at $0.25		$1,500
Dam cut-off [2]			
Dry excavation	600 cu. yds. at 1.50	$900	
Wet excavation	200 cu. yds. at 5.00	1,000	
Concrete core	540 cu. yds. at 14.00	7,560	9,460
Outlet structure			
Excavation	280 cu. yds. at 1.25	350	
Concrete	157.5 cu. yds. at 26.00	4,095	
Gate, frame and screen		3,500	7,945
Spillway			
Excavation placed in dam	27,000 cu. yds. at 0.60	16,200	
Concrete lining	533 cu. yds. at 17.00	9,061	25,261
Dam embankment			
Borrowed fill	8,200 cu. yds. at 0.65		5,330
Rip-rap facing	3,000 cu. yds. at 1.25		3,750
	Total		$53,246
Engineering and contingencies at 25%			13,311
Interest during construction at 6% compounded semiannually			
For first year work of stripping, cut-off, outlet, engineering and contingencies (for 1½ years)		1,786	
For second year work of completing structure		2,881	4,667
Total cost of construction			$71,224

[1] Unit construction prices are on the same basis as used in other reports of the Division of Water Resources dealing with the Central Valley Project of California. It is known, however, that even during the period of high prices in the 1920's dams were built by private interests in Modoc County for much less.

[2] While detail investigation of foundation at the dam site has not been made, there are no surface indications that difficulties will be met.

Cost of right of way is not included in the foregoing estimate. Exclusive of interest on this, the annual amortization charge at 6% interest and retirement of debt in 20 years, would be $0.74 per acre served. The increased hay crop and fall pasture made possible by the additional water, at the average prices received for hay and pasture during the ten years preceding 1932, would be sufficient to pay the above amortization charge and interest on any conceivable price for right of way, and in addition yield a considerable profit.

The construction of the reservoir would inundate about 1000 acres of meadow lands which now have a full season water supply, but this

loss would be practically offset by new lands that could be brought into the project. The net benefit would be measured by the increased value of a full season supply for the 9000 acres of land in the project now inadequately irrigated.

Ash Creek Canyon Reservoir Site.

A possible reservoir site in Ash Creek canyon near the Ryan Place was surveyed by the Division in 1931. The area and capacity data for such reservoir are given in Table 37.

The run-off available for storage at this site would be practically the same as for the Ash Valley site.

TABLE 37

AREA AND CAPACITY OF PROPOSED ASH CREEK CANYON RESERVOIR

Depth of water in feet (above stream bed at dam)	Area of water surface in acres	Capacity in acre-feet
10	4	0
20	20	120
30	39	419
40	65	939
50	94	1,734
60	130	2,856
70	168	4,347
80	211	6,243

It is apparent from the area and capacity data that the relatively small capacity of the reservoir as compared with the height of dam required, makes this project infeasible.

Round Valley Reservoir Site.

This site has been discussed in previous reports covering the upper Pit River area, particularly in the U. S. Reclamation Service report. It is located on Ash Creek, immediately northeast of Adin. The run-off available for storage in Round Valley, as estimated from the records of the stream gaging station on Ash Creek near Adin, is shown in Table 38. The area and capacity data for the reservoir are given in Table 39.

TABLE 38

ESTIMATED RUN-OFF AVAILABLE FOR STORAGE AT ROUND VALLEY RESERVOIR SITE

For the Period November 1 to April 15—Watershed Area 251 Square Miles

Season	Run-off in acre-feet	Season	Run-off in acre-feet
1918–19	26,600	1925–26	25,800
1919–20	27,400	1926–27	43,200
1920–21	52,500	1927–28	46,200
1921–22	40,700	1928–29	15,300
1922–23	20,800	1929–30	26,600
1923–24	18,800	1930–31	11,300
1924–25	28,600		
		Average	29,500

TABLE 39

AREA AND CAPACITY OF PROPOSED ROUND VALLEY RESERVOIR

Depth of water in feet above stream bed at dam	Area of water surface, in acres	Capacity in acre-feet
0	0	0
10	65	218
20	304	2,060
30	528	6,220
40	918	13,500
50	1,430	25,200
60	2,060	42,700
70	2,860	67,300
80	3,560	99,400

An analysis of the data pertaining to the Round Valley project is submitted in Table 40.

TABLE 40

ANALYSIS OF PROPOSED ROUND VALLEY RESERVOIR

Item	Size of development		
	For [illegible] acres on Ash Creek	For 20,000 acres in Big Valley	Maximum possible
Required storage capacity, in acre-feet	13,000	50,000	61,000
Average gross annual reservoir yield, in acre-feet	12,300	25,500	29,500
Average water surface area, in acres	600	1,250	2,000
Average annual reservoir losses, in acre-feet (estimated)	3,300	5,500	6,800
Average annual safe delivery, in acre-feet	9,000	20,000	22,700
Depth of water, in feet	40	63	68
Height of dam (approximate), in feet	50	75	80
Inundated area, in acres	600	2,300	2,700
Estimated earthfill dam yardage	74,000	200,000	225,000
Estimated spillway requirements, in second-feet	15,000	13,000	12,000
Estimated cost of dam at $1.50 per cubic yard, overall	$111,000	$300,000	$337,500
Estimated cost of highway relocation at $35,000 per mile	175,000	210,000	245,000
Engineering and contingencies at 25%	71,500	127,500	145,625
Estimated total construction cost	357,500	637,500	728,125
Construction cost per acre-foot delivered	$39.72	$31.88	$32.08

The cost of the lands which would be inundated by the reservoir has not been included in the above estimate.

The Redding-Alturas Lateral of the State Highway system passes directly through the proposed dam and reservoir sites, and its relocation would involve from 5 to 7 miles of new highway construction, half of which would be on side hills. It is apparent from the estimates that the cost of such relocation would be so high as to render the project infeasible.

Willow Creek Reservoir Site.

There appears to be only one reservoir site on Willow Creek above the major irrigated area on the stream. This site is located where the creek emerges through the low foothills onto the floor of Big Valley. The area and capacity data for this reservoir, as determined by a transit and stadia survey made by the Division in 1931, are given in Table 41.

TABLE 41

AREA AND CAPACITY OF PROPOSED WILLOW CREEK RESERVOIR

Depth of water in feet (above stream bed at dam)	Area of water surface, in acres	Capacity in acre-feet
2	1	0
12	4	25
22	43	260
32	116	1,053
42	199	2,628
52	307	5,160
62	396	8,676
72	491	13,114

An earthfill dam at this site, 40 feet high to give a storage capacity of about 2500 acre feet, would require about 76,000 cubic yards of embankment. The cost of such a structure would be prohibitive.

Dixie Valley Reservoir Site.

The topography of Dixie Valley offers a satisfactory reservoir site with a dam at the outlet of the valley.

The estimated run-off available for storage, for the 13 year period from 1918 to 1931, is shown in Table 42.

The area and capacity data, based upon a reconnaissance plane-table survey made by the State Division of Engineering and Irrigation in 1922, are presented in Table 43.

TABLE 42

ESTIMATED RUN-OFF AVAILABLE FOR STORAGE AT DIXIE VALLEY RESERVOIR SITE

For the Period November 1 to April 15—Watershed Area 186 Square Miles

Season	Run-off in acre-feet	Season	Run-off in acre-feet
1918–19	3,380	1925–26	2,700
1919–20	3,540	1926–27	6,080
1920–21	7,280	1927–28	6,480
1921–22	6,470	1928–29	3,030
1922–23	2,840	1929–30	6,880
1923–24	2,540	1930–31	2,620
1924–25	4,170		
		Average	4,460

TABLE 43

AREA AND CAPACITY OF PROPOSED DIXIE VALLEY RESERVOIR

Depth of water in feet (above stream bed at valley outlet)	Area of water surface, in acres	Capacity in acre-feet
0	0	0
10	360	1,200
20	1,160	8,500
30	2,660	24,000
40	3,970	50,000
50	4,780	91,000
60	5,450	142,000
70	6,100	205,000

An analysis of the data indicates that this reservoir would inundate more irrigated land than could be served with the average

water supply that would be available; hence this project is considered infeasible.

Little Valley Reservoir Site.

A reservoir could be created in Little Valley by the construction of a dam at the outlet.

The estimated run-off available for storage, as derived from the records obtained at the stream gaging station on Horse Creek below Little Valley, is shown in Table 44.

TABLE 44

ESTIMATED RUN-OFF AVAILABLE FOR STORAGE AT LITTLE VALLEY RESERVOIR SITE

For the Period November 1 to April 15—Watershed Area, 234 Square Miles

Season	Run-off in acre-feet	Season	Run-off in acre-feet
1918–19	5,900	1925–26	5,040
1919–20	6,100	1926–27	9,300
1920–21	10,800	1927–28	9,800
1921–22	9,790	1928–29	5,460
1922–23	5,220	1929–30	10,300
1923–24	4,840	1930–31	4,940
1924–25	6,890		
		Average	7,260

The site has never been surveyed to accurately determine the capacity of the reservoir. It is roughly estimated that a dam 50 feet high, allowing 10 feet freeboard, would impound approximately 13,500 acre-feet. On this basis, the following analysis is presented:

Average gross annual reservoir yield	6,800 acre-feet
Storage required to develop average yield	13,500 acre-feet
Average hold-over storage	4,000 acre-feet
Average total annual storage	10,800 acre-feet
Average annual reservoir losses (estimated)	1,800 acre-feet
Average annual safe delivery	5,000 acre-feet
Deficiency during past 11 years	0

Inasmuch as there is no agricultural area within the territory covered by this investigation which is susceptible to irrigation from this source, no estimate of the cost of the reservoir has been made.

TABLES OF BASIC DATA

TABLE 45

MISCELLANEOUS DISCHARGE MEASUREMENTS, UPPER PIT RIVER AND TRIBUTARIES

Streams listed in their order downstream

Name of stream	Location of point of measurement	Gage height, feet	Discharge, c.f.s.	Date
North Fork Pit River	SW¼ Sec. 5, T. 42 N., R. 13 E.		233	5/24/17
	SW¼ Sec. 5, T. 42 N., R. 13 E.		85	6/15/17
	Below all diversions		37	6/15/17
	County bridge, Alturas		81	1/7/04
	Alturas		11	11/30/17
	Alturas		3.6	5/27/18
	Alturas		1.9	6/27/18
	Alturas		2.0	12/7/18
	Alturas		25	3/9/19
	Alturas		18	3/9/19
	Alturas		323	4/20/19
	Alturas		.3	5/18/19
	Alturas		1.0	7/4/19
	Alturas		4.0	9/14/21
	At head of canyon		5.35	7/10/29
	At Cedarville Highway		14.96	6/18/29
	Below Lauer Dam		.83	7/9/29
	At railroad bridge		.30	11/11/29
	Above Joseph Creek		7.25	4/1/30
	Above Parker Creek		56.48	4/1/30
	Above Parker Creek		28.94	5/14/30
	Below Thoms Creek		9.25	3/13/31
	Below Thoms Creek		2.81	4/16/31
	Below Thoms Creek		1.50	5/14/31
	Below Thoms Creek		50	7/1/31
	One mile above Surprise Station		30	7/1/31
	At old county road crossing		3.72	3/13/31
Linville Creek	100 feet below power house		2.4	8/16/24
	100 feet below power house		1.8	8/26/24
	100 feet below power house		3.3	9/27/24
	100 feet below power house		3.9	10/6/24
	100 feet below power house		3.5	10/17/24
	100 feet below power house		2.6	10/25/24
Franklin (Swedrengen) Creek	Above diversions		1.6	8/26/24
	Above diversions		2.3	9/27/24
	Above diversions		2.4	10/6/24
	Above diversions		2.0	10/17/24
	Above diversions		2.6	10/25/24
Joseph Creek	Above diversions		7	8/27/24
	Above diversions		4	9/27/24
	Above diversions		3.70	5/13/30
	Above diversions		2.74	6/9/30
	Above diversions		40	9/5/30
	Above diversions		8	10/6/24
	Above diversions		.5	10/16/24
	Above diversions		.4	10/25/24
	Above junction with Couch Creek		30	9/5/30
	Above junction with Couch Creek		1.50	7/1/31
	Below McElwain-Freeman-Kipp		02	7/1/30
	Below McElwain-Freeman-Kipp		05	9/5/30
	At North Fork of Pit River		18.91	4/1/30
	At North Fork of Pit River		7.02	5/13/30
	At North Fork of Pit River		1.98	6/9/30
	At North Fork of Pit River		05	9/5/30
	Below old road crossing		2.23	4/1/31
	Below old road crossing		27	4/16/31
	Below old road crossing		.10	5/14/31
	Below old road crossing		20	7/1/31
Couch Creek (tributary to Joseph Creek)	1,000 feet west of McElwain house		8	9/27/24
	1,000 feet west of McElwain house		1.2	10/6/24
	1,000 feet west of McElwain house		1.0	10/16/24
	1,000 feet west of McElwain house		1.0	10/25/24
	Above diversions		2.76	5/13/30
	Above diversions		1.32	6/9/30
	Above diversions		.30	9/5/30
	Above junction with Joseph Creek		30	9/5/30
	Above junction with Joseph Creek		50	7/1/31
Thoms Creek	Above diversions		5	9/23/24
	Above diversions		7	10/7/24
	Above diversions		6	10/22/24
	Above diversions	2.32	8.88	4/15/30

TABLE 45—Continued

MISCELLANEOUS DISCHARGE MEASUREMENTS, UPPER PIT RIVER AND TRIBUTARIES

Name of stream	Location of point of measurement	Gage height, feet	Discharge, c.f.s.	Date
Thoms Creek—Continued	Above diversions		1.89	6/11/30
	Above diversions		1.46	6/26/30
	Above diversions		.34	9/6/30
	Above diversions		9.84	4/1/31
	Above diversions		1.25	5/14/31
	Above diversions		.50	7/1/31
	Below DeWitt Upper Left Ditch		.05	6/26/30
	At Hayes Upper Line		.10	9/5/30
	Below Hayes Upper Right Ditch		.02	6/26/30
	Below Hayes Lower Left Ditch		.01	6/26/30
	Below Hayes Lower Right Ditch		.015	6/26/30
	Below Stiner Upper Ditch		.02	6/30/30
	Below Stiner Lower Ditch		.02	6/30/30
	At old county road crossing		.35	7/1/30
	Below old county road crossing		10.48	4/1/31
	Below old county road crossing		2.04	4/16/31
	Below old county road crossing		.10	5/14/31
	Below old county road crossing		.04	7/1/31
	At North Fork of Pit		31.73	4/1/30
	At North Fork of Pit		16.31	5/13/30
Mile Creek (tributary to Thoms Creek)	At old mill		.19	6/26/30
	At old mill		.05	9/5/30
	At Royce place	2.59	1.94	4/15/30
	At road below Royce house		2.00	4/1/31
	At road below Royce house		.00	7/1/31
Parker Creek	Sec. 28, T. 42 N., R. 14 E. above Shields Creek		1.0	8/27/24
	Sec. 28, T. 42 N., R. 14 E. above Shields Creek		1.0	8/28/24
	Sec. 28, T. 42 N., R. 14 E. above Shields Creek		1.1	9/11/24
	Sec. 28, T. 42 N., R. 14 E. above Shields Creek		2.0	9/28/24
	Sec. 28, T. 42 N., R. 14 E. above Shields Creek		3.9	10/7/24
	Sec. 28, T. 42 N., R. 14 E. above Shields Creek		2.6	10/15/24
	Above diversions		33.69	5/6/30
	Above diversions		31.41	5/23/30
	Above diversions		9.99	6/13/30
	Above diversions		1.19	9/3/30
	Above diversions		13.14	4/9/31
	Above diversions		.82	8/6/31
	Above diversions		.91	8/10/31
	Above diversions		.77	8/12/31
	Above diversions		.77	8/26/31
	Above diversions		.91	9/7/31
	Above diversions		.86	9/14/31
	Above diversions		1.07	9/21/31
	Below Payne Ranch		31.92	5/23/30
	Below Stanton Upper Dam		.47	7/8/30
	Right Channel below Stanton Lower Dam		.10	7/8/30
	Left Channel opposite Stanton Lower Dam		1.10	7/8/30
	700 feet above North Fork Pit River		1.56	7/9/29
	At mouth at XL Ranch		1.99	11/11/29
	At mouth at XL Ranch		1.29	6/20/30
	At mouth at XL Ranch		.63	6/23/30
	At mouth at XL Ranch		.05	9/3/30
	Below Trumbo diversions		8.14	4/9/31
	Below Fogarty Dam		.50	8/6/31
	Below Fogarty Dam		.99	8/12/31
	Below Fogarry Dam		.63	8/26/31
	Below Fogarty Ranch		.33	9/3/30
	At county road crossing		.05	9/3/30
	At county road crossing		.30	3/7/31
	At county road crossing		.50	9/14/31
	At county road crossing		.60	9/21/31
Shields Creek (tributary to Parker Creek)	½ mile above Archer ranch (McDowell)		1.8	8/28/24
	½ mile above Archer ranch (McDowell)		1.8	9/11/24
	½ mile above Archer ranch (McDowell)		1.5	9/28/24
	½ mile above Archer ranch (McDowell)		1.8	10/7/24
	½ mile above Archer ranch (McDowell)		1.5	10/15/24
	Above diversions		9.50	5/6/30
	Above diversions		2.74	9/3/30

TABLE 45—Continued

MISCELLANEOUS DISCHARGE MEASUREMENTS, UPPER PIT RIVER AND TRIBUTARIES

Name of stream	Location of point of measurement	Gage height, feet	Discharge, c.f.s.	Date
Shields Creek (tributary to Parker Creek) Continued	Above ranger station road crossing		3 56	6/ 5/30
	At ranger station road		3 29	4/ 9/31
	At county road crossing		4 16	6/ 5/30
	At county road crossing		1 91	9/ 3/30
	Above McDowell diversions		1 28	8/ 8/31
	Above McDowell diversions		1 28	8/12/31
	Above McDowell diversions		1 25	8/20/31
	Above McDowell diversions		1 22	8/26/31
	Above McDowell diversions		1 42	9/ 7/31
	Above McDowell diversions		1 28	9/14/31
	Above McDowell diversions		1 63	9/21/31
	Above Trumbo house		78	8/ 8/31
	Below Page ditch		1.39	9/ 3/30
	Below Page ditch		.76	8/ 6/31
	Below Page ditch		74	8/10/31
	Below Page ditch		.70	8/26/31
South Fork Pit River	Old U. S. G. S. station at Jess Valley		4 9	8/17/24
	Above West Valley Creek	4 78	[a]133	4/19/26
	Above West Valley Creek	4 68	[a]107	4/24/26
	Above West Valley Creek	3 41	[a]15.4	7/ 2/26
	Below West Valley Creek		9 9	8/17/24
	Below West Valley Creek	.53	11	8/23/24
	Below West Valley Creek	59	15	9/17/24
	Below West Valley Creek	60	16	9/30/24
	Below West Valley Creek	78	25	10/21/24
	Below West Valley Creek	78	26	10/26/24
	Below West Valley Creek	1 58	130	4/30/26
	Below West Valley Creek	53	12	9/15/26
	Below West Valley Creek	1 04	277	5/30/27
	Above Roy Williams ranch	8 63	[a]147	4/19/26
	Above Roy Williams ranch	8 53	[a]115	4/24/26
	Above Roy Williams ranch	7 67	[a]14 2	7/ 2/26
	Above Roy Williams ranch	7 85	[a]32 3	7/ 7/27
	Above Roy Williams ranch	7 68	[a]21 6	8/27/27
Mill Creek	North Fork below Payne Ditch		[a]2 00	5/28/31
	150 feet below Mill Creek Falls		6 1	9/ 5/24
	150 feet below Mill Creek Falls		8 1	9/22/24
	150 feet below Mill Creek Falls		7 7	9/30/24
	150 feet below Mill Creek Falls		6 2	10/21/24
	150 feet below Mill Creek Falls		7 0	10/26/24
	Above Homestead Ditch		[c]20 45	5/23/31
	Above Homestead Ditch		11 62	6/ 2/31
	Above Homestead Ditch		10 38	6/19/31
	Above Homestead Ditch		6 62	7/ 7/31
	Above Homestead Ditch		4 38	7/28/31
	Above Homestead Ditch		4 54	8/10/31
	Above Homestead Ditch		4 69	9/12/31
	Below Brooks Upper Ditch		.10	6/ 3/31
	Below Brooks Upper Little Creek Ditch		.05	6/ 3/31
	Below Brooks Lower Little Creek Ditch		05	6/ 3/31
	Below Brooks Lower Little Creek Ditch		05	6/23/31
	Below Brooks Lower Ditch		.05	6/ 3/31
	Below Brooks Lower Ditch		.05	6/23/31
	500 feet below Beardsley fence		[c]15 61	5/18/31
	Bridge below Beardsley ranch		9 96	5/27/31
	Bridge below Beardsley ranch	53	10 09	6/ 3/31
	Bridge below Beardsley ranch		7 76	6/19/31
	Bridge below Beardsley ranch	28	3 77	7/ 7/31
	Bridge below Beardsley ranch		3 38	7/28/31
Soup Creek (tributary to Mill Creek)	Sec. 24, T. 40 N., R. 14 E.		[b].42	9/12/24
	Sec. 24, T. 40 N., R. 14 E.		[b].36	9/30/24
	Sec. 24, T. 40 N., R. 14 E.		[b].66	10/21/24
	Sec. 24, T. 40 N., R. 41 E.		[b].99	10/26/24
	Head of Brooks upper ranch		.45	5/27/31
	Lower end Brooks upper ranch		09	5/27/31
Beardsley Spring Creek (tributary to Mill Creek)	Sec. 36, T. 40 N., R. 14 E.		12	5/27/31
Flournoy-Spargur Spring Creek (tributary to Mill Creek)	Sec. 1, T. 39 N., R. 14 E.		48	6/19/31

TABLE 45—Continued

MISCELLANEOUS DISCHARGE MEASUREMENTS, UPPER PIT RIVER AND TRIBUTARIES

Name of stream	Location of point of measurement	Gage height, feet	Discharge, c.f.s.	Date
East Creek	Sec. 13, T. 39 N., R. 15 E. below 3 small ditches		7.3	9/20/24
	Sec. 13, T. 39 N., R. 15 E. below 1 small ditch		10.0	9/22/24
	Sec. 13, T. 39 N., R. 15 E. below 1 small ditch		9.0	9/30/24
	Sec. 13, T. 39 N., R. 15 E.		12	10/21/24
	Sec. 13, T. 39 N., R. 15 E.		9.2	10/26/24
	Above diversions		9.38	8/5/30
	Above diversions		[c]14.75	5/22/31
	Above diversions		9.94	6/3/31
	Above diversions		9.41	6/19/31
	Above diversions		6.20	7/7/31
	Above diversions		4.70	7/28/31
	Above diversions		4.65	8/11/31
	Above diversions		6.42	9/19/31
	Below Campbell-Flournoy fence		7.81	6/4/31
	Below Campbell-Flournoy fence		7.48	6/19/31
	Below Campbell-Flournoy fence		4.82	7/7/31
	Below Campbell-Flournoy fence		3.41	7/28/31
	Below Flournoy diversions		1.00	8/22/31
	Below Flournoy diversions		.88	9/5/31
Harvey Creek	Above diversions		2.4	9/20/24
	Above diversions		1.4	9/30/24
	Above diversions		2.1	10/21/24
	Above diversions		4.3	10/26/24
	Above diversions		[c]1.64	5/21/31
	Above diversions		1.58	6/5/31
	Above diversions		1.81	6/25/31
	Above diversions		1.76	7/8/31
West Valley Creek	Above Van Loan Ditch		9.9	9/5/24
	Above Van Loan Ditch		10	9/17/24
	Above Van Loan Ditch		12	10/1/24
	Above Van Loan Ditch		9.76	5/29/31
	Above Van Loan Ditch		8.63	6/8/31
	Above Van Loan Ditch		9.87	6/24/31
	Above Van Loan Ditch		7.29	7/7/31
	Above Van Loan Ditch		7.51	7/28/31
	Above Van Loan Ditch		9.06	8/15/31
	Above Van Loan Ditch		9.40	8/21/31
	Above Van Loan Ditch		7.00	8/31/31
	Above Van Loan Ditch		7.04	9/10/31
	Abandoned gaging station near mouth	3.00	14	8/19/24
	Abandoned gaging station near mouth	2.74	5.8	8/23/24
	Abandoned gaging station near mouth	2.90	9.7	10/1/24
	Abandoned gaging station near mouth	3.00	14	10/21/24
	At South Fork Pit River		1.5	7/2/26
Warm Creek (tributary West Valley Creek)	Sec. 15, T. 38 N., R. 14 E.		[b]*.25	8/19/24
	Above diversions		.39	5/29/31
	Above diversions		.38	6/24/31
	Above diversions		.34	7/7/31
Cedar Creek	Sec. 32, T. 38 N., R. 14 E.		[b].70	8/25/24
	Sec. 32, T. 38 N., R. 14 E.		[b].76	10/10/24
Stone Canyon	Above diversions		3.03	4/4/30
Fitzhugh Creek	Near Alturas		2.7	9/15/04
	Doten ranch, 10 miles South of Alturas		1.8	7/2/05
	Doten ranch, 10 miles south of Alturas		1.4	7/25/05
	Doten ranch, 10 miles south of Alturas		1.8	9/7/05
	Doten ranch, 10 miles south of Alturas		2.8	9/16/05
	1,000 feet below junction N. and S. Forks		[b]2.83	8/29/24
	1,000 feet below junction N. and S. Forks		[b]1.63	9/8/24
North Fork Fitzhugh Creek	Sec. 28, T. 41 N., R. 14 E.		[b].35	9/8/24
	Sec. 28, T. 41 N., R. 14 E.		[b].36	9/29/24
	Sec. 28, T. 41 N., R. 14 E.		[b].71	10/14/24
South Fork Fitzhugh Creek	Sec. 3, T. 40 N., R. 14 E.		[b]1.31	9/8/24
	Sec. 3, T. 40 N., R. 14 E.		[b]1.89	9/29/24
	Sec. 3, T. 40 N., R. 14 E.		[b]2.41	10/14/24

TABLE 45—Continued

MISCELLANEOUS DISCHARGE MEASUREMENTS, UPPER PIT RIVER AND TRIBUTARIES

Name of stream	Location of point of measurement	Gage height, feet	Discharge, c.f.s.	Date
Pine Creek	7 miles east of Alturas		12.4	8/11/05
	7 miles east of Alturas		11.3	8/22/05
	Above Power Diversion		17.24	4/16/30
	Above Power Diversion		7.61	7/20/31
	Below Power Diversion		2.90	4/16/30
	Below Power Diversion		.50	7/20/31
	Above Power House		19.96	6/15/30
	Near Cor. 27-28-33-34, T. 42 N., R. 13 E.		5.24	4/30/30
	At Sweeney Lane		7.00	5/29/30
	At Sweeney Lane		2.98	8/29/30
Slough out of South Fork of Pit River	At railroad bridge Alturas		9.68	4/21/30
Roy Williams Reservoir Spring	Below S. P. tracks		1.00	6/26/31
Spring east of S. P. Tank	At outlet		.00	6/26/31
Spring at S. P. Tank	Below S. P. tank overflow		.18	6/26/31
Spring west of S. P. Tank	Below S. P. tracks		.59	6/26/31
Geo. Williams House Spring	At head of ditch		.21	6/29/31
Geo. Williams Milk House Spring	Below small reservoir		.16	7/1/31
Big Spring Creek	Geo. Williams ranch		3.78	6/29/31
Little Valley Spring Creek	Geo. Williams ranch		1.65	7/1/31
Smokey Charlie Spring	Sec. 13, T. 39 N., R. 12 E.		b* .65	10/11/24
	Sec. 13, T. 39 N., R. 12 E.		b* .53	10/23/24
	North of Stone Canyon		.11	7/1/31
Sim Bayley (Metzler Springs)	Sec. 11, T. 39 N., R. 12 E.		b* .40	10/11/24
	Sec. 11, T. 39 N., R. 12 E.		b* .10	10/23/24
	South of Christensen		.22	7/1/31
Indian Springs No. 1 (Roy Williams)	Sec. 21 & 22, T. 39 N., R. 13 E.		b 1.07	9/4/24
	Sec. 21 & 22, T. 39 N., R. 13 E.		b .82	10/1/24
	Sec. 21 & 22, T. 39 N., R. 13 E.		b .85	10/11/24
	Sec. 21 & 22, T. 39 N., R. 13 E.		b 1.15	10/24/24
Indian Springs No. 2	Sec. 21 & 22, T. 39 N., R. 13 E.		b .41	9/4/24
	Sec. 21 & 22, T. 39 N., R. 13 E.		b .27	10/13/24
	Sec. 21 & 22, T. 39 N., R. 13 E.		b .20	10/24/24
Indian Springs No. 3	Sec. 21 & 22, T. 39 N., R. 13 E.		b* .10	10/13/24
	Sec. 21 & 22, T. 39 N., R. 13 E.		b* .10	10/24/24
Indian Springs No. 4	Sec. 21 & 22, T. 39 N., R. 13 E.		b* .10	10/13/24
	Sec. 21 & 22, T. 39 N., R. 13 E.		b* .05	10/24/24
Indian Springs No. 5	Sec. 21 & 22, T. 39 N., R. 13 E.		b .18	10/1/24
	Sec. 21 & 22, T. 39 N., R. 13 E.		b* .15	10/13/24
	Sec. 21 & 22, T. 39 N., R. 13 E.		b* .05	10/24/24
Indian Springs No. 6 (Spring west of S. P. tank)	Sec. 21 & 22, T. 39 N., R. 13 E.		b 1.69	10/13/24
	Sec. 21 & 22, T. 39 N., R. 13 E.		b 1.20	10/24/24
Indian Springs No. 7	Sec. 17, T. 39 N., R. 13 E.		b* .40	10/11/24
	Sec. 17, T. 39 N., R. 13 E.		b* .30	10/24/24
Indian Springs No. 8	Sec. 17, T. 39 N., R. 13 E.		b* .20	10/11/24
	Sec. 17, T. 39 N., R. 13 E.		.24	10/24/24
McGarva Springs and Creek (Holden or Bergstrom Springs)	Sec. 19, T. 39 N., R. 13 E.		b 3.55	9/3/24
	Sec. 19, T. 39 N., R. 13 E.		b 5.19	9/23/24
	Sec. 19, T. 39 N., R. 13 E.		b 5.54	10/2/24
	Sec. 19, T. 39 N., R. 13 E.		b 5.35	10/11/24
	Sec. 19, T. 39 N., R. 13 E.		b 5.34	10/23/24
Geo. Williams Springs and Creek	Sec. 24, T. 39 N., R. 12 E.		b 4.93	9/3/24
	Sec. 24, T. 39 N., R. 12 E.		b 6.34	10/2/24
	Sec. 24, T. 39 N., R. 12 E.		b 6.64	10/8/24
	Sec. 24, T. 39 N., R. 12 E.		b 8.55	10/23/24

TABLE 45—Continued

MISCELLANEOUS DISCHARGE MEASUREMENTS, UPPER PIT RIVER AND TRIBUTARIES

Name of stream	Location of point of measurement	Gage height, feet	Discharge, c.f.s.	Date
Pit River (Hot Springs Valley)	Kelly Lane		78.9	5/30/29
	½ mile below McBrien Dam		101	6/16/17
	3 miles below Canby		.5	9/13/21
Rattlesnake Creek (Big Sage Reservoir water)	Big Sage outlet	1.275	36.80	6/2/31
	Big Sage outlet	.635	4.81	7/17/31
	Big Sage outlet	.190	.30	9/4/31
	500 feet below Big Sage Dam		66.26	7/3/30
	Above Spicer meadow		63.99	5/29/29
	Above Spicer meadow		87.46	6/16/30
	Above Spicer meadow		69.31	7/4/30
	Below Spicer diversion		47.35	4/15/31
	Below Spicer diversion		50.48	4/16/31
	Below Spicer diversion		57.47	4/18/31
	Below Spicer diversion		60.39	4/19/31
	Below Spicer diversion		47.30	4/25/31
	Below Spicer diversion		80.89	5/9/31
	Below Spicer diversion		80.74	5/11/31
	Below Spicer diversion		50.28	5/27/31
	Below Spicer diversion		34.75	5/29/31
	Below Spicer diversion		13.92	6/4/31
	Below Spicer diversion		70.01	6/11/31
	Below Spicer diversion		54.80	6/17/31
	Below Spicer diversion		45.41	6/22/31
Canyon Creek	Above diversions		1.8	8/31/24
	Above diversions		2.7	9/26/24
	Above diversions		2.5	10/4/24
	Above diversions		3.0	10/20/24
	Above diversions		1.8	9/14/26
	Above diversions	2.70	7.98	4/3/30
	Above diversions	2.65	5.55	4/17/30
	Above diversions	2.56	2.91	6/3/30
	Above diversions	1.51	1.68	6/27/30
	Above diversions	2.50	1.68	7/3/30
	Above diversions	2.49	1.57	8/2/30
	Above diversions	2.51	1.87	8/14/30
	Above diversions	2.50	1.68	9/6/30
	Above diversions	2.41	3.43	4/2/31
	Above diversions	2.33	2.03	5/18/31
	Above diversions	2.29	1.20	7/2/31
	Above diversions		1.26	9/17/31
	Above Essex ranch	.75	3.17	4/17/30
	Above Essex ranch	.45	.58	9/6/30
	Near Centerville		3.8	9/14/04
Toms Creek	Sec. 34, T. 41 N., R. 10 E.		[b].78	8/31/24
	Sec. 34, T. 41 N., R. 10 E.		[b].95	9/26/24
	Sec. 34, T. 41 N., R. 10 E.		[b].73	10/4/24
	Sec. 34, T. 41 N., R. 10 E.		[b].95	10/20/24
	Road crossing above Marlett ranch		1.00	7/2/31
	Road crossing below Marlett ranch		.25	7/2/31
	Above Caldwell diversions	2.55	8.02	4/3/30
	Above Caldwell diversions	2.39	3.54	4/14/30
	Above Caldwell diversions	2.46	5.00	4/26/30
	Above Caldwell diversions	2.55	7.30	6/3/30
	Above Caldwell diversions	2.30	2.34	6/27/30
	Above Caldwell diversions	2.32	2.29	7/3/30
	Above Caldwell diversions	2.45	4.60	8/2/30
	Above Caldwell diversions	1.96	.67	4/2/31
	Above Caldwell diversions	2.21	3.20	5/19/31
	Above Caldwell diversions		2.00	7/2/31
	Above Caldwell diversions	1.93	.60	9/17/31
Hot Creek (Essex Baths)	Sec. 9, T. 42 N., R. 11 E.		[b]1.61	9/1/24
	Sec. 9, T. 42 N., R. 11 E.		[b]2.03	9/25/24
	Sec. 9, T. 42 N., R. 11 E.		[b]2.58	10/5/24
	Sec. 9, T. 42 N., R. 11 E.		[b]2.30	10/18/24
	Sec. 9, T. 42 N., R. 11 E.		[b]2.47	10/30/24
	50 feet below Highway		2.00	7/16/31
Arthur Essex Spring	Sec. 21, T. 41 N., R. 11 E.		[b]1.13	10/10/24
	At outlet		1.13	9/6/30
	At outlet		.96	5/18/31
Phillip Essex Spring	At Highway		1.15	7/16/31

TABLE 45—Continued

MISCELLANEOUS DISCHARGE MEASUREMENTS, UPPER PIT RIVER AND TRIBUTARIES

Name of stream	Location of point of measurement	Gage height, feet	Discharge, c.f.s.	Date
Essex Spring Creek	Sec. 26, T. 43 N., R. 10 E.		[b].46	9/ 1/24
	Sec. 26, T. 34 N., R. 10 E.		[b].53	10/ 4/24
	Sec. 26, T. 43 N., R. 10 E.		[b].84	10/19/24
	Sec. 26, T. 43 N., R. 10 E.		[b].87	10/30/24
S. X. or Huffman Springs	Sec. 12, T. 42 N., R. 10 E.		[b*].33	9/ 1/24
	Sec. 12, T. 42 N., R. 10 E.		[b].58	10/30/24
	Near head of ditch		.58	3/26/31
Kelly Hot Springs	Sec. 29, T. 42 N., R. 10 E.		[b].56	8/31/24
	Sec. 29, T. 42 N., R. 10 E.		[b].54	9/25/24
	Sec. 29, T. 42 N., R. 10 E.		[b].86	10/ 4/24
	Sec. 29, T. 42 N., R. 10 E.		[b].95	10/19/24
	Sec. 29, T. 42 N., R. 10 E.		[b].65	10/30/24
	At outlet		.74	4/ 5/30
	At outlet		.78	4/11/30
	At outlet		.95	7/15/31
Cooley Spring	Sec. 12, T. 41 N., R. 9 E.		.30	8/ 4/30
Townsend Spring	Sec. 12, T. 41 N., R. 9 E.		1.20	8/ 4/30
Allen Spring	Sec. 12, T. 41 N., R. 9 E.		.60	8/ 4/30
Pit River (Big Valley)	½ mile below Turner Creek		1.8	8/30/24
	½ mile below Turner Creek		6.6	10/ 3/24
	½ mile below Turner Creek		12	10/19/24
	½ mile below Turner Creek		31	10/31/24
	1 mile below Turner Creek		8.4	9/24/24
	Gould bridge (Gouger Neck)		1.5	8/13/24
	Gould bridge (Gouger Neck)		2.2	9/19/24
	Lookout		155	6/13/05
	Lookout		57	7/ 7/05
	Lookout		29	7/20/05
	Lookout		9.9	8/19/05
	Lookout		2	9/13/21
	Bieber		5	9/13/21
	Muck Valley	4.01	427	5/30/27
	Muck Valley	1.94	8.6	7/24/28
Turner Creek	Sec. 35, T. 42 N., R. 8 E.		[b].20	8/30/24
	Sec. 35, T. 42 N., R. 8 E.		[b].62	9/24/24
	Sec. 35, T. 42 N., R. 8 E.		[b].58	10/ 3/24
	Sec. 35, T. 42 N., R. 8 E.		[b].44	10/19/24
	Sec. 35, T. 42 N., R. 8 E.		[b]1.19	10/31/24
Ash Creek	Ash Valley		194	4/ 5/04
	Ash Valley		189	5/ 5/04
	Ash Valley		30	6/ 4/04
	Ash Valley		27	6/10/04
	Sec. 29, T. 39 N., R. 10 E.	55	18	8/20/24
	Sec. 29, T. 39 N., R. 10 E.	58	18	9/19/24
	Sec. 29, T. 39 N., R. 10 E.	61	18	8/21/25
	Sec. 29, T. 39 N., R. 10 E.	58	16	4/29/26
	Sec. 29, T. 39 N., R. 10 E.	54	14	9/14/26
	Sec. 29, T. 39 N., R. 10 E.	58	15	9/28/26
	Sec. 29, T. 39 N., R. 10 E.	58	16	9/28/26
	Sec. 29, T. 39 N., R. 10 E.	1.02	40	5/29/27
	Above Kresge Dam		11.71	6/ 2/29
	Adin		10	9/13/21
Cottonwood Creek (tributary Ash Creek)	300 feet above junction with Ash Creek		6.24	3/24/30
Rush Creek (tributary Ash Creek)	Round Valley		12	6/12/04
	Round Valley		7.0	8/30/04
	Round Valley		5.6	7/18/05
	Round Valley		5.8	9/22/05
	2 miles above mouth, below 1 small diversion		2.2	9/16/24
	2 miles above mouth, below 1 small diversion		2.6	9/25/24
	2 miles above mouth, below 1 small diversion	4.27	3.46	11/13/29
	2 miles above mouth, below 1 small diversion	4.30	5.67	5/13/30
	2 miles above mouth, below 1 small diversion	4.23	2.79	6/ 9/31
Butte Creek (tributary Ash Creek)	Head of Bath Upper Ditch		.21	6/10/31
	Below Bath irrigated land		.42	6/10/31
	Sec. 24, T. 38 N., R. 10 E.		[b].30	8/15/24
	Above head Niles Upper Ditch		.52	6/10/31

TABLE 45—Continued

MISCELLANEOUS DISCHARGE MEASUREMENTS, UPPER PIT RIVER AND TRIBUTARIES

Name of stream	Location of point of measurement	Gage height, feet	Discharge, c.f.s.	Date
Willow Creek (tributary Ash Creek)	Near Adin		5.6	8/29/04
	Near Adin		5.0	9/20/04
	Near Adin		5.7	7/19/05
	Near Adin		4.4	9/21/05
	6 miles above mouth		5.7	8/15/24
	6 miles above mouth		5.6	9/25/24
	6 miles above mouth		4.6	8/21/25
	6 miles above mouth		5.6	9/16/26
	6 miles above mouth		5.2	9/28/26
Widow Valley Creek	½ mile below Vicker ranch house		4.3	8/12/24
	½ mile below Vicker ranch house		4.5	9/19/24
	½ mile below Vicker ranch house		4.7	9/16/26
	½ mile below Vicker ranch house		4.1	9/28/26
	½ mile below Vicker ranch house		10	5/29/27
Pit River (below Big Valley)	Sec. 3, T. 36 N., R. 6 E.		8.2	5/21/24
	Sec. 3, T. 36 N., R. 6 E.		10	10/21/24
	Pittville		30	9/11/03
	Pittville		36	8/16/11
	Pittville		31	9/24/10
	Pittville		12	9/19/24
	Pittville		25	10/24/24
	Pittville		32	5/14/25
	Pittville		33	5/21/25
	Pittville		29	7/2/25
	Pittville		47	7/9/25
	Pittville		29	7/16/25
	Pittville		41	7/23/25
	Pittville		30	7/31/25
	Pittville		1.2	10/1/25
	Pittville		1.1	10/8/25
	Pittville		1.2	10/15/25
	Pittville		*.2	10/22/25
	Pittville	.50	15	8/9/27
	Pittville	.45	11	9/7/27
	Pittville		51	5/17/28
	Pittville		58	5/24/28
	Pittville		56	5/31/28
	Pittville		59	6/7/28
	Pittville		35	6/14/28
	Pittville	1.39	54	6/21/28
	Pittville	.87	31	6/28/28
	Pittville	.95	35	7/9/28
	Pittville	.56	17	7/20/28
	Pittville	.46	13	8/2/28
	Pittville	.50	10	9/6/28
	Pittville	.47	11	9/7/28
	Pittville	1.49	65	11/7/28
	Pittville	1.40	60	11/9/28
	Pittville	1.68	84	11/20/28
	Pittville	2.22	277	3/28/29
	Pittville	1.73	112	4/5/29
	Pittville	2.04	177	4/10/29
	Pittville	2.11	202	4/15/29
	Pittville	2.76	533	4/23/29
	Pittville	2.40	302	5/2/29
	Pittville	1.98	147	5/3/29
	Pittville	.48	12	5/23/29
Horse Creek	Lower end Dixie Valley		2.81	7/2/31
	Lower end Dixie Valley		3.38	9/19/31
	Head of Bognuda ranch		2.68	7/2/31
	In Little Valley		9.4	2/18/24
	Lower end Little Valley		7.6	11/24/28
	At mouth		4.2	9/5/24
	At mouth		3.9	10/4/24
Spring in Dixie Valley	Below C. W. Clark ranch house		2.36	7/2/31
Bobs Creek	Sec. 23, T. 36 N., R. 6 E.		[b].27	9/5/24
	0.3 miles above county road crossing		.35	7/3/31
Beaver Creek	Near mouth		3.2	8/12/24
	Near mouth		3.3	10/24/24

Records prior to October 1, 1928, obtained from publications of Water Resources Branch United States Geological Survey, except as noted below:

[a] Records of Division of Water Resources prior to this investigation.

[b] Records of Pacific Gas and Electric Company.

[c] Measurements by W. J. Archer.

*Discharge estimated.

TABLE 46

CROP YIELDS ON TYPICAL LANDS IRRIGATED FROM UPPER PIT RIVER AND TRIBUTARIES

1930 and 1931

Name	1930						1931					
	Crop	Acres	Number of irrigations	Total yield		Water supply	Crop	Acres	Number of irrigations	Total yield		Water supply
				Tons	Sacks					Tons	Sacks	
Jess Valley												
Brooks, Walter S. (Up.)	Meadow hay	75	8	50		3/4 normal	Meadow hay	75	10+	25		3/8 normal
Brooks Walter S. (Lwr.)	Meadow hay	120	(1)	130		Plenty	Meadow hay	120	(1)	120		3/4 normal
Cantrall, A. J.	Meadow hay	100	(1)	130		Normal	Meadow hay	100	(1)	100		1/2 normal
	Orchard	0.3	10	1			Orchard	0.3	10			
	Potatoes	0.5	3	2.5			Potatoes	0.5	3	1		
	Garden	0.5	10	1			Garden	0.5	10	0.75		
	Pasture	100	(1)				Pasture	100	(1)			
Cantrall, Walter	Alfalfa	6	2	12		Normal	Alfalfa	6	1	6		1/2 normal
	Grain hay	3		3			Meadow hay	161	(1)	160		
	Meadow hay	161	(1)	180			Orchard	1	3	0.25		
	Orchard	1	3	2			Potatoes	0.25	2			
	Potatoes	0.5	2	1.5			Garden	0.25	10			
	Garden	0.25	10				Pasture	50	(1)			
	Pasture	50	(1)									
Leoni, F.	Meadow hay	140		160		Normal	Meadow hay	140		106		1/2 normal
	Pasture	180					Pasture	180				
West Valley												
Van Loan, J. C.	Grain hay		2	75		1/2 normal	Grain hay		2	75		1/2 normal
	Meadow hay	800	10	800			Meadow hay	800	10	800		
	Orchard	1	4	1			Orchard	1	4			
South Fork Valley												
Armstrong, W. E.	Meadow hay	560	(1)	600			Meadow hay	30	1	35		No water after April 10
	Pasture	200	(1)				Pasture	200				
Christensen, Victor F.	Alfalfa	100	1	150		2/3 normal	Alfalfa	100	0.5	50		1/4 normal
	Meadow hay	2,000	2	4,000			Grain hay	400	1	400		
	Barley	400	2		3,735		Meadow hay	2,000	0.67	2,000		

Coffman, A. I.	Alfalfa	40	2	60			Alfalfa	30	1	30		
	Meadow hay	100	10	100			Grain hay	30	1	30		
	Garden	0.5	(1)				Meadow hay	100	6	50		
	Potatoes	5	2				Pasture	40	(1)			
	Pasture	40	(1)									
Dorris, W. J.*	Alfalfa	160	(2)	300			Meadow hay	200	6	250		
	Meadow hay	460	10	690			Pasture	500				
	Alfalfa	200	2	150								
	Potatoes	1	10		100							
	Pasture	500	6									
Gaustad, R. O.	Meadow hay	50	3	100		Normal	Meadow hay	75	1	115		3/4 normal
Gaustad, R. J.	Meadow hay	165	3	390		Normal	Meadow hay	165	1	200		3/4 normal
Graham and Stepp	Meadow hay	100	2	220		3/4 normal	Meadow hay	100	1	154		1/4 normal
McArthur, Frank	Meadow hay	4,000	3	6,873			Grain hay	400	0.10	70		
	Barley	310	1				Meadow hay	4,000	1	2,485		
	Sugar beets	15	3	290			Wheat	50	3		497	
	Pasture	137	3				Sugar beets	10	2	(3)		
							Pasture	97	2			
McGarva, John M.	Meadow hay	200	1.5	500		1/2 normal	Meadow hay	200	1	250		1/4 normal
	Pasture	300	3				Pasture	300	3			
Van Loan, D. E.	Grain hay	150	2	200		3/4 normal	Meadow hay	860	1	740		1/2 normal
	Meadow hay	900	3	1,350			Pasture	360	1			
	Pasture	170	6									
Williams, Royal E.	Alfalfa	30		45		1/2 normal	Alfalfa	30	2	30		
	Meadow hay	300		450			Meadow hay	300		300		
	Stock beets	10		60								
Williams, Geo. E.	Alfalfa	25	5	45		Normal	Alfalfa	25	5	100		Normal
	Grain hay	20	5	30			Meadow hay	240	6	307		
	Meadow hay	220	6	226			Orchard	1	6			
	Orchard	1	6				Potatoes	1	2		20	
	Potatoes	1	2		40		Pasture	140				
	Pasture	140	8									
North Fork												
Bettandorff, Chas.	Alfalfa	20	2	60			Alfalfa	30	1	40		
	Grain hay	30	0	25			Grain hay	41	0	7		
	Barley	11	(2)		113		Rye	20	0	(4)		
	Rye	20	0		49							
	Wheat	25	1		78							

TABLE 46—Continued

CROP YIELDS ON TYPICAL LANDS IRRIGATED FROM UPPER PIT RIVER AND TRIBUTARIES

1930 and 1931

Name	1930						1931					
	Crop	Acres	Number of irrigations	Total yield		Water supply	Crop	Acres	Number of irrigations	Total yield		Water supply
				Tons	Sacks					Tons	Sacks	
North Fork—Continued												
De Witt, Alfred	Meadow hay	35	1	45			Meadow hay	35	1	25		
	Orchard	0.5	3	3.5			Orchard	0.5	3	0.5		
	Pasture	30	2				Pasture	30	2			
Johnson, J. M.	Alfalfa	75					Alfalfa	75				
	Grain hay	100		650		Shortage	Grain hay	100		500		Very short
	Meadow hay	825					Meadow hay	825				
	Garden	0.5	(1)				Garden	0.5	(1)			
Johnson, J. M. (Parker Creek)	Alfalfa	150	2	125		½ normal	Alfalfa	150	1	90		⅓ normal
	Meadow hay	50	2	25			Meadow hay	50	1	10		
Laver & Sons, L. B.	Alfalfa	33	1	120		⅔ normal	Alfalfa	27	1	110		⅓ normal
	Barley	20	1		500		Grain hay	45	1	47		
	Oats	5	1		100		Meadow hay	30	1	30		
	Rye	15	1		100		Barley	10	1		60	
	Wheat	10	1		250		Oats	2	1		50	
	Pasture	30	(1)				Wheat	10	1		150	
Lynip, B. F.	Alfalfa	200	1	400		½ normal	Alfalfa	200	1	200		½ normal
	Grain hay	280	1	200			Meadow hay	300	1	100		
	Meadow hay	300	1	100								
McArthur, Frank	Alfalfa	30	2	60			Wheat	170	0		1,100	
	Alfalfa Seed	40		(4)								
	Wheat	150	1		1,870							
McDowell, L. G.	Meadow hay	200	11	125		½ normal	Meadow hay	200	4	90		¼ normal
McElwain, E. S.							Meadow hay	50		35		
Page Ranch	Meadow hay	160		75		Shortage						

Porter, Alice	**Meadow hay**	**100**		**65**		**⅓ normal**	**Meadow hay**	**100**		**35**		**⅓ normal**
	Rye	50		(¹)								
	Garden	0.5			10							
Porter, Pearl	Alfalfa	35	2	50		½ normal	Alfalfa	35	1	45		1/6 normal
	Meadow hay	20	2	75			Grain hay	44	1	44		
	Barley	12			80		Meadow hay	20		40		
	Rye	25			30							
	Wheat	35			52							
	Orchard	0.75		1								
Renner, Metan	Mixed hay	40	0.5	50		½ normal	Mixed hay	40	0	35		⅓ normal
Royce, Howard	Alfalfa	.0	0.5			½ normal	Alfalfa	10	1			½ normal
	Meadow hay	20	1				Grain hay	5	1			
	Rye	5	1				Meadow hay	20	1			
	Potatoes	0.25					Wheat	5	1			
	Pasture	80					Garden	0.5	1			
							Potatoes	0.25	1			
							Pasture	80				
Royce, J. M.	Mixed hay	30		30		70% normal	Grain hay	6		3		1/5 normal
Royce, J. M. (Thoms Creek)	Mixed hay	15		12		65% normal	Mixed hay	15	1	10		½ normal
	Potatoes		0		20							
Stanton, Wm.	Alfalfa	5	2	5		½ normal	Meadow hay	112	10	90		¼ normal
	Meadow hay	112	20	140			Orchard	0.13	1		0	
	Orchard	0.13	4		40		Garden	0.12	5			
	Garden	0.12	8				Potatoes	0.13	2		8	
	Potatoes	0.13	4		15		Pasture	45				
	Pasture	40										
Pine Creek												
Cantrall, Lawrence A.	Meadow hay	160	(¹)	150		¾ normal	Meadow hay	100	10	100		½ normal
	Wheat	29			57		Orchard					
	Orchard	1					Garden	0.1				
	Garden	0.1					Pasture	20				
	Pasture	20										
Cantrall, S. A.	Grain hay	20	0			⅓ normal	Grain hay	20	0			⅓ normal
	Meadow hay	60					Meadow hay	60				
	Barley	15	5				Garden	1				
	Wheat	15	7				Pasture	120				
	Garden	1										
	Pasture	120										

TABLE 46—Continued

CROP YIELDS ON TYPICAL LANDS IRRIGATED FROM UPPER PIT RIVER AND TRIBUTARIES

1930 and 1931

Name	1930						1931					
	Crop	Acres	Number of irrigations	Total yield		Water supply	Crop	Acres	Number of irrigations	Total yield		Water supply
				Tons	Sacks					Tons	Sacks	
Pine Creek—Continued												
Dorris, W. J.**	Meadow hay	340	10	500			Alfalfa	160	(2)	200		
							Meadow hay	340	8	400		
Estes, C. A.	Grain hay			10			Meadow hay			50		
	Meadow hay			100								
	Barley				320							
Goulden, Dorothy	Grain hay	55		55		½ normal	Meadow hay	25	1	20		1/5 normal
	Meadow hay	120		100								
	Pasture	20										
Heesch, H. A.	Alfalfa	10	2	20		Normal	Grain hay	6	1	8		½ normal
	Grain hay	6	2	10			Meadow hay	80	(1)	100		
	Meadow hay	100	(1)	130			Garden	0.25				
	Garden	0.25	10		15		Potatoes	0.25	2	(3)		
	Potatoes	0.25	4		15		Pasture	40	1			
	Pasture	40	8									
Leoni, F.	Alfalfa	100		240		Normal	Alfalfa	20		60		⅓ normal
	Meadow hay	130		140			Meadow hay	40		50		
	Orchard	4		8			Orchard	4				
	Potatoes	0.5			15		Potatoes	0.5				
	Pasture	200					Pasture	200				
Wall, E. H.	Alfalfa	17	3	25			Alfalfa	17	0	0		Practically no water
	Meadow hay	200	(1)	300			Meadow hay	200	1	130		
	Barley	30	2		200		Barley	30	0	0		
	Oats	30	2		196		Oats	30	0	0		
	Wheat	7			60		Wheat	8	0		15	
	Orchard	5	4									
	Garden	0.5										

Weber, P. C.	Alfalfa	87	1	180		½ normal	Alfalfa	23	2	92		⅓ normal
	Meadow hay	354	1	450			Meadow hay	150	1	150		
	Garden	0.25	5				Potatoes	0.28	1	(*)		
	Potatoes	0.50	1		60		Pasture	3				
	Pasture	3										
Hot Springs Valley												
Spicer Company	Alfalfa	40	3	75		Normal	Alfalfa	40	2	65		Normal
	Meadow hay	340	2	400			Meadow hay	360	3	360		
Kelley Brothers	Alfalfa	125	2	350		About normal	Alfalfa	125	2	225		¾ normal
	Potatoes	1	3		85		Potatoes	1	3		40	
	Wheat	30	⅓		125		Grain hay	6	1	10		
Cummings, J. W.	Alfalfa	60	4	75		Normal	Alfalfa	80	3	60		¾ normal
	Grain hay	20	2	20			Grain hay	10	1	10		
	Potatoes	5	5	15	300		Potatoes	20	4	100	2,000	
McFessel, Gus (McArthur, F., 1931)	Meadow hay	540	4	480		¾ normal	Meadow hay	650	3	425		
Green, Max	Meadow hay	130	7	150		¾ normal	Meadow hay	130	4	100		½ normal
Claussen Ranch (Modoc County Bank)	Meadow hay						Meadow hay	20	3	25		
Connelly Ranch (Modoc County Bank)							Meadow Hay	150	3	125		
Fitzhugh, J. M.	Meadow hay	200	5	365		Normal	Meadow hay	200	3	245		½ normal
Hulbert, I. N.	Meadow hay	135	2	180		¾ normal	Meadow hay	135	2½	122		½ normal
Kramer, G. L.							Meadow hay	150	2	150		
Caldwell, F. W.	Meadow hay	140	4	205		Normal	Meadow hay	140	2	80		⅔ normal
Hughes, H. C. (M. Goch Est.)	Meadow hay	80	2	80		Normal	Meadow hay	80	2	40		½ normal
Pope, Lizzie D.	Meadow hay			40			Meadow hay			61		
Toms Creek												
Caldwell, F. W.	Alfalfa	280	3	315		Normal	Alfalfa	200	2	110		⅓ normal
Kramer, J. L.							Meadow hay	100	2	115		

TABLE 46 Continued

CROP YIELDS ON TYPICAL LANDS IRRIGATED FROM UPPER PIT RIVER AND TRIBUTARILS

1930 and 1931

Name	1930						1931					
	Crop	Acres	Number of irrigations	Total yield		Water supply	Crop	Acres	Number of irrigations	Total yield		Water supply
				Tons	Sacks					Tons	Sacks	
Ash Creek												
Armstrong, A. E.	Alfalfa	25	2	25		½ normal	Alfalfa	25	2	30		⅓ normal
	Garden	0 25	2				Garden	0 25	2			
	Potatoes	0 25	2		10		Potatoes	0 25	2			
Bath, H. S.	Alfalfa	40	0	50		¾ norma	Alfalfa	60	0	50		½ normal
	Grain hay	10	0	10			Meadow hay	70	1	70		
	Meadow hay	70	1	90			Rye	10	0	10		
	Garden	0 10					Garden	0 10				
	Potatoes	0 05	3		10		Potatoes	0 05	3		10	
	Pasture	70					Pasture	70				
Bassett, S. K.	Alfalfa	20	0	25			Alfalfa	20	0	7		
	Wheat	150			2,124		Wheat	150			1,613	
Babcock Brothers	Alfalfa	50	1	50		Normal	Pasture	25	2			
	Pasture	30	2									
Barrows, T. A.	Grain hay	10	(3)	20		Normal	Grain hay	30		60		Normal
	Meadow hay	260		300			Meadow hay	260		332		
	Potatoes	1			30		Potatoes	1				
	Pasture	59					Pasture	59				
Cannon, A. L.	Meadow hay	180	(1)	200		⅘ normal	Meadow hay	180	(1)	200		Shortage
Finney, L. H.	Alfalfa	40	1	58		¾ normal	Alfalfa	15	0	1		No water
	Grain hay	11	0	14 5			Grain hay	65	0	55		
Neptune Ranch	Meadow hay	50	2	73			Meadow hay	25	0	13		
	Wheat	33	0		218							
	Orchard	0 02										
	Pasture	240										
Holbrook, John	Alfalfa	30		175		½ normal	Alfalfa	30		150		½ normal
	Grain hay	4					Meadow hay	150				
	Meadow hay	150					Orchard		15			
	Orchard		20				Garden		2			

	Garden		2				Potatoes		3			
	Potatoes		3									
Knight, S. E.	Meadow hay	300					Meadow hay	300				
	Orchard	2					Orchard	2				
Kresge, John A.	Meadow hay	20	1	35		¾ normal	Alfalfa	3	1	6		¾ normal
							Meadow hay	25	1	30		
Kresge, John A. (Springs)	Alfalfa	12	1.5	30		Normal	Alfalfa	12	2	40		Normal
	Grain hay	5	1	10			Grain hay	5	1	10		
	Meadow hay	35	1	55			Meadow hay	30	1	50		
Kresge, N. S.	Grain hay	12	2	3		¾ normal						
	Meadow hay	40	7	1.5								
	Garden	0.25	60									
Lane, J. C.	Grain hay	75	(²)	75			Grain hay	75		75		
	Meadow hay	120	1	120			Meadow hay	100	1	100		
	Rye				40							
	Wheat				300							
	Pasture	100										
Miller, J. P.	Alfalfa	30	3	75			Alfalfa	10	3	25		
	Meadow hay	150	1	150			Meadow hay	150	0.5	75		
Niles, S. J.	Alfalfa	15	0.5	65		½ normal	Alfalfa	30	0	40		¼ normal
	Grain hay	65	0	100			Grain hay	40	0	45		
	Meadow hay	75	0.5	175			Meadow hay	71	1	130		
	Garden	0.5	8				Orchard	1	2			
	Potatoes	0.5					Garden		8			
							Potatoes	0.25	1			
Roseberry, Viola M.	Meadow hay	100	1	85			Meadow hay	100	1	72		
Studley, Frank H.	Alfalfa	3.5	4	6		⅗ normal	Alfalfa	3.5	2	6		⅗ normal
	Meadow hay	225	10				Grain hay	10	2	1.5		
	Orchard	1					Meadow hay	215	10	1.5		
	Garden	0.25					Orchard	1	6			
	Potatoes	0.5					Garden	0.25	10			
	Pasture	50					Potatoes	0.5	2			
							Pasture	50				
Steiger, L. M.	Meadow hay	90		125		¾ normal	Meadow hay	90		60		¼ normal
Walker, F. E.	Meadow hay	100		120		¾ normal	Meadow hay	100	(¹)	75		½ normal
Weigand, Kasper	Alfalfa	15	1	25			Alfalfa	15	1	10		
	Meadow hay	160	1	250			Meadow hay	160	1	200		

TABLE 46—Continued

CROP YIELDS ON TYPICAL LANDS IRRIGATED FROM UPPER PIT RIVER AND TRIBUTARIES

1930 and 1931

Name	1930 Crop	1930 Acres	1930 Number of irrigations	1930 Total yield Tons	1930 Total yield Sacks	1930 Water supply	1931 Crop	1931 Acres	1931 Number of irrigations	1931 Total yield Tons	1931 Total yield Sacks	1931 Water supply
Big Valley												
Babcock Brothers	Alfalfa	180	3	325		Above normal	Alfalfa	200	1	200		¼ normal
	Meadow hay	300	3	350			Meadow hay	300	1	80		
	Wheat	85			900		Wheat	90			210	
	Pasture	400					Pasture	300				
Gerig, Peter	Meadow hay	265	4	400		Normal	Meadow hay	265	1 5	179		3/8 normal
Holl, James	Meadow hay	250	3	200		½ normal	Meadow hay	125	1	80		1-10 normal
	Pasture	60					Pasture	60				
Jones, E. A.	Meadow hay	75	1	75		¼ normal	Meadow hay	75	1	1/8		No water
Kramer, G. L.	Meadow hay	300	2	300		½ normal						No water
Kramer, G. L.***	Meadow hay	800	3	900		¾ normal	Meadow hay	900	3	1,000		¾ normal
Menser, J. T.	Grain hay	50	1	3		½ normal	Grain hay	75	1	3		⅓ normal
	Meadow hay	150	3	150			Meadow hay	150	3	150		
	Wheat	50	1		15		Wheat	50	1		20	
Robinson, E. C., and Elliott	Orchard	1	2			Normal	Orchard	1	2			Normal
	Garden	0.25	10				Garden	0.75	10			
	Pasture	0.25	4				Pasture	0.25	4			
Thompson, S. J.	Meadow hay	80	2	50		¾ normal	Meadow hay	80	1	20		⅓ normal

*Also served by Pine Creek and North Fork Pit waters.
**Also served with South Fork and North Fork Pit River waters.
***Water from Widow Valley Creek.
[1] Continuous.
[2] Subirrigated.
[3] Not harvested.
[4] Failure.

TABLE 47

SUMMARY OF CROP YIELDS ON TYPICAL LANDS IRRIGATED FROM UPPER PIT RIVER AND TRIBUTARIES,

1930 and 1931

Area	1930				1931			
	Crop	Average number of irrigations	Yield per acre	[1]Average per cent of normal	Crop	Average number of irrigations	Yield per acre	[1]Average per cent of normal
Jess Valley	Alf.	2.0	2.0 tons	100	Alf.	1.0	1.0 tons	About 50
	G. H.	2.0	2.0 tons		G. H.	2.0	No data	
	M. H.	Cont.	1.1 tons		M. H.	Cont.	0.9 tons	
	Orch.	6.0	2.0 tons		Orch.	6.0	0.3 tons	
	Pot.	2.5	4.0 tons		Pot.	2.5	2.0 tons	
	Gar.	10.0	1.0 tons		Gar.	10.0	No data	
	P.	Cont.			P.	Cont.		
South Fork Valley	Alf.	2.5	1.5 tons	About 75	Alf.	2.1	1.6 tons	About 50
	G. H.	3.5	1.4 tons		G. H.	0.7	0.7 tons	
	M. H.	4.9	1.7 tons		M. H.	2.3	1.2 tons	
	Bar.	1.5	14.3 sacks		Wht.	3.0	9.9 sacks	
	Su. Bts.	3.0	2.0 tons		Su. Bts.	2.0	Failure	
	St. Bts.		6.0 tons		Orch.	6.0	No data	
	Orch.	6.0	No data		Pot.	2.0	20.0 sacks	
	Gar.	Cont.	No data		P.	6.0		
	Pot.	4.7	70.0 sacks					
	P.	6.6						
Pine Creek	Alf.	2.0	2.0 tons	About 60	Alf.	2.0	2.7 tons	About 33
	G. H.	2.0	1.3 tons		G. H.	1.0	1.3 tons	
	M. H.	8.0	1.2 tons		M. H.	5.0	1.0 tons	
	Bar.	3.5	6.7 sacks		Wht.		1.9 tons	
	Oats	2.0	6.5 sacks		Orch.	No	data	
	Wht.	3.5	5.3 sacks		Gar.	No	data	
	Orch.	2.5	2.0 tons		Pot.	1.5	Failure	
	Gar.	7.5	60.0 sacks		P.	2.0		
	Pot.	2.5	50.0 sacks					
	P.	8.0						
North Fork Valley and tributaries.	Alf.	1.6	2.0 tons	About 50	Alf.	1.0	1.7 tons	About 33
	G. H.	1.0	0.8 tons		G. H.	1.0	0.7 tons	
	M. H.	5.4	1.1 tons		M. H.	2.7	0.7 tons	
	Mix. H.	0.5	1.0 tons		Mix. H.	1.0	0.8 tons	
	Bar.	1.0	14.3 sacks		Bar.	1.0	6.0 sacks	
	Oats	1.0	20.0 sacks		Oats	1.0	25.0 sacks	
	Rye	1.0	7.6 sacks		Wht.	1.0	10.7 sacks	
	Wht.	1.0	10.5 sacks		Orch.	2.0	1.0 tons	
	Orch.	3.5	3.2 tons		Gar.	9.0	No data	
	Gar.	10.0	10.0 sacks		Pot.	1.5	64.0 sacks	
	Pot.	4.0	120.0 sacks		P.	2.0		
	P.	10.0						
Toms Creek	Alf.	3.0	1.1 tons	100	Alf.	2.0	0.6 tons	About 33
	M. H.	No	data		M. H.	2.0	1.2 tons	
Hot Springs Valley (Area irrigated from Pit River and Big Sage waters).	Alf.	3.0	2.0 tons	100	Alf.		1.4 tons	About 50
	M. H.	3.8	1.3 tons		M. H.	2.8	0.9 tons	
	G. H.	2.0	1.0 tons		G. H.		1.4 tons	
	Wht.	0.3	4.2 sacks		Wht.	No	data	
	Pot.	4.0	72.0 sacks		Pot.		70.0 sacks	
Big Valley	Alf.	3.0	1.8 tons	100	Alf.	1.0	1.0 tons	About 25
	G. H.	1.0	0.1 tons		G. H.	1.0	0.1 tons	
	M. H.	2.6	1.0 tons		M. H.	1.6	0.6 tons	
	Wht.	1.0	6.8 sacks		Wht.	1.0	1.6 sacks	
	Pot.	4.0	100.0 sacks		Pot.	4.0	No data	
	Orch.	2.0	No data		Orch.	2.0	No data	
	Gar.	10.0	No data		Gar.	10.0	No data	

TABLE 47—Continued

SUMMARY OF CROP YIELDS ON TYPICAL LANDS IRRIGATED FROM UPPER PIT RIVER AND TRIBUTARIES

1930 and 1931

Area	1930				1931			
	Crop	Average number of irrigations	Yield per acre	[1]Average per cent of normal	Crop	Average number of irrigations	Yield per acre	[1]Average per cent of normal
Ash Creek and tributaries.	Alf.	1.7	1.9 tons	About 75	Alf.	1.8	1.4 tons	About 50
	G. H.	1.7	1.3 tons		G. H.	1.5	1.2 tons	
	M. H.	3.0	1.3 tons		M. H.	3.5	1.0 tons	
	Wht.		10.4 sacks		Rye		1.0 tons	
	Orch.	7.7	No data		Wht.		10.8 sacks	
	Gar.	18.0	No data		Orch.	7.7	No data	
	P.	2.0			Gar.	5.5	No data	
					P.	2.0		

[1] Water supply.

Crop Abbreviations:

Alf. —Alfalfa	Mix. H.—Mixed Hay	Pot. —Potatoes	Su. Bts.—Sugar Beets
G. H. —Grain Hay	Bar. —Barley	Orch. —Orchard	St. Bts.—Stock Beets
M. H. —Meadow Hay	Gar. —Garden	P. —Pasture	Wht. —Wheat

TABLE 48

ACREAGE IRRIGATED FROM UPPER PIT RIVER AND TRIBUTARIES

Source	Name	Crop acreage										
		Meadow hay	Grain hay and meadow hay	Alfalfa and meadow hay	Alfalfa	Grain	Meadow pasture	Pasture	Grain hay	Orchard	Garden	Total
Jess Valley Area												
East Creek	Geo. D. Campbell	51.3			8.1			1.5			3.7	64.6
	J. D. Flournoy Co.	1,103.2					54.8	684.6		0.4		1,843.0
Mill Creek	A. J. Cantrall	75.0				2.5		76.5				154.0
	Walter Cantrall	71.1			12.0		40.2	53.9		0.4	0.8	178.4
	W. S. Brooks	127.5										127.5
	Della Beardsley and Bessie Johnson	70.2						53.6				123.8
	Fehee Leom	53.8				1.7	34.5	51.6		1.2	3.1	145.9
	J. D. Flournoy Co.	133.8					145.2					279.0
Soup Creek	W. S. Brooks	53.8						21.0			1.3	76.1
	A. J. Cantrall	6.7				4.3						11.0
Harvey Creek	J. D. Flournoy Co.	643.3						34.0				677.3
Coyote Creek	J. D. Flournoy Co.							151.5				151.5
West Valley Area												
West Valley Creek	J. C. Van Loan	477.6				21.9		80.8			3.4	583.7
Parsnip Creek	P. B. McGarva (Blue Lake Ranch)							123.8				123.8
South Fork Area												
South Fork Pit River	R. C. Turrittin	129.0			26.0							155.0
	R. E. Williams and Marion G. Williams	238.3			17.7							256.0
	Indian Allotment	28.4						15.5				43.9
	A. Tornquist (Blevins)	94.0										94.0
	Douglas McGarva	33.0										33.0
	F. A. Benedict and F. S. Benedict	15.4										15.4
	John Blevins and Cecil Blevins	101.2										101.2
	D. E. Van Loan	1,058.0						18.0				1,076.0
	A. T. Coffman			163.7							8.0	171.7
	Jack Williams Est. (Indian Allotment)	28.4										28.4
	Indian Allotment	29.7						2.5			0.1	32.3
	S. J. Vaughon	17.3										17.3
	J. D. Flournoy Company	1,051.7										1,051.7
	N. E. McKee	30.8										30.8

	Ivie McGarva and M. McGarva	112.6										112.6
	Geo. E. Williams and Eva B. Williams	360.7										360.7
	Gary Williams	475.1										475.1
	F. E. Humphrye and V. F. Christensen	1,287.5				348.2	50.5	87.2				1,773.4
	W. H. and Gladys Flournoy	377.1			22.5	92.0						491.6
	A. K. Flournoy	298.0										298.0
	A. L. Stinson	7.0										7.0
	Willie W. Hughes and Jesse A. Hughes	309.6			117.0							426.6
	P. B. and John McGarva	219.5										219.5
	R. J. Gaustad	175.0										175.0
	R. O. Gaustad	152.0										152.0
	Raymond Stepp et al.	90.0										90.0
	Malinda A. Bowman	173.3										173.3
	Mrs. Katie H. Nelson	430.0						96.3				526.3
	W. E. Armstrong	206.0										206.0
	Frank McArthur	4,973.3			55.5	312.5	32.0	221.6				5,594.9
	Frank McArthur	14.2						42.1				56.3
	E. O. Thomas	12.2										12.2
	J. Thomas	14.1										14.1
	P. S. Dorris	461.8										461.8
	Open Land Sec. 24, T. 41 N., R. 12 E.	12.9										12.9
	Webber and Moffit	20.9			119.6	33.0	5.0	10.0				188.5
	W. E. Armstrong	277.0										277.0
Crooks Canyon	F. E. Humphrey and V. F. Christensen					160.0						160.0
Fitzhugh Creek	John Blevins and Cecil Blevins	53.8						12.8			0.9	67.5
	Philip Derevan										2.0	2.0
	Minnie Derevan	63.0						2.6		1.0		66.6
	Walter Cantrell							77.4				77.4
	Cornelia Hershey et al. (Yankee Jim)							112.6				112.6
	Geo. M. Clark and J. E. Clark	209.7			112.3							322.0
	Frank McArthur	149.5			293.3		139.0	28.0				609.8
	W. E. Armstrong	30.0										30.0
North Fork Area												
North Fork Pit River	M. and I. Woody	9.7					1.6	47.8				59.1
	X. L. Land and Cattle Company	316.7			103.5						3.2	423.4
	Frank McArthur				113.5	500.0				8.1		621.6
	C. Bettandorff				43.3							43.3
	B. F. Lynip				364.5	132.0		17.8				514.3
	Smith and Jackson	63.3			67.2							130.5
	Mrs. M. Hughes	158.0				2.3						160.3
	M. F. Hughes			61.6		67.3						128.9
	Anne Lauer	143.4										143.4
	W. J. Dorris				190.4							190.4
	J. C. Neer				2.0							2.0
	M. J. Gloster				43.7							43.7
	T. A. and B. Walls				81.8							81.8
	A. F. McDowell	55.2		29.5								84.7
	J. T. Laird Estate				81.0							81.0

TABLE 48 Continued

ACREAGE IRRIGATED FROM UPPER PIT RIVER AND TRIBUTARIES

Source	Name	Crop acreage										
		Meadow hay	Grain hay and meadow hay	Alfalfa and meadow hay	Alfalfa	Grain	Meadow pasture	Pasture	Grain hay	Orchard	Garden	Total
Franklin Creek	Ira A. and Ida M. Hanson	33.7								7.5	0.7	41.9
	Earl and Mary Ehrman	14.3								0.9		15.2
	P. Indart	76.5			15.6		20.7			2.2	2.7	117.7
	G. R. Stone				27.4		3.8			0.9	2.5	34.6
	John and Fannie Morrison	142.1				22.5	2.1			1.2		167.9
	Paulina Lee	131.6				15.8	15.7			0.6	1.0	164.7
	Ella M. Shartell	10.1									0.2	10.3
	J. G. and Mattie M. Dawson	104.7										104.7
	Earl and Bernice Sherer						24.9	42.7				67.6
	C. E. Crowder et al.	184.7										184.7
Mud Lake Reservoir	G. L. Wakerly					17.0						17.0
Joseph Creek and Couch Creek	M. and L. Espil						48.6					48.6
	V. L. and G. Jacobs						29.1					29.1
	D. B. Robnett	69.5									0.2	69.7
	K. Wilson	4.1										4.1
	E. S. McElwain	37.2					0.5				0.5	38.2
	M. C. and M. Freeman and D. E. Knapp	337.1					15.9	148.4				501.4
	O. Gibbons	0.2										0.2
Thoms Creek and tributaries, Bowlin, Martin and Mile Creeks.	G. I. Jones	17.5									1.4	18.9
	Herman Acty	2.5				0.4						2.9
	Alfred DeWitt	10.9				55.1				1.5	2.2	69.7
	Howard and Pearl Royce			37.1							1.3	38.4
	Clyde and Ruth Hays	22.5			1.6						1.2	25.3
	Daniel Royce	18.2				0.6						18.8
	J. M. Royce			6.1							1.5	7.6
	Albert Stiner and Sons	9.7	7.3									17.0
	Mary S. Renner	2.1	22.6								0.3	25.0

	Milan S. Renner		4.1									4.1
	J. L. and G. W. Gilcher	21.1										21.1
	Geo. L. Baker			8.1	13.8	10.5						32.4
	XL Land and Cattle Co.	1.3										1.3
Parker Creek and tributaries, Gleason, Plum, and Shields Creek.	L. G. McDowell											142.5
	Alice Porter (Pepperdine)											46.5
	E. D. Payne											121.0
	W. S. Trumbo											205.5
	W. M. Stanton											118.5
	John Page											237.5
	Cahn Fogerty											123.5
	Alice Porter											199.0
	Pearl Porter											153.0
	Phear Porter											45.5
	James Porter											192.0
	XL Land and Cattle Co.	149.9		159.5								309.4
	David Reid	9.7				74.1						83.8
	J. M. Royce			4.0	25.6	4.0					1.0	30.1
	J. and E. Jones	60.7			6.0	9.0	3.1					78.8
	D. Reid						22.7					22.7
Linville Creek	B. A. and M. C. Crabtree									3.7	1.2	4.9
	E. A. and M. Erhman	81.8						26.7		4.1		112.6
	C. C. and B. Clark	14.6					13.0					27.6
	B. Clark	61.5			26.0		35.6					123.1
	J. B. Webb	51.0					14.9					65.9
	Lake Shore Cattle Co.	319.2										319.2
Pine Creek	E. H. Wall and Agnes A. Wall	246.8			14.8	6.4						268.0
	S. A. Cantrall	50.8			34.4	84.8		59.2				229.2
	Lawrence Cantrall	156.8				2.4						159.2
	Felice Leoni	104.0			95.6	16.0	30.8	40.4			11.2	298.0
	Mary M. Dorris					126.4						126.4
	W. S. and Alice B. Trumbo	260.8			66.2						2.0	329.0
	W. J. Dorris[a]	938.0			201.6			139.0				1,278.6
	Hans Heesch	96.0			15.4	5.6		37.2				154.2
	Dorothy Goulden	139.7				122.5	43.0					305.2
	Peter C. Webber	323.6			44.8	8.4		8.4				385.2
	J. H. Thomas	100.0				35.4	11.6					147.0
	Clarence A. Estes	80.0				67.0						147.0
	Frank McArthur	130.0			35.6							165.6
	H. D. Essex	130.0						8.4				138.4
	P. S. Dorris[a]	1,528.0										1,528.0
Hot Springs Valley Area												
Pit River	P. S. Dorris							39.0				39.0
	Hoy and Christen							77.0				77.0

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TABLE 48—Continued

ACREAGE IRRIGATED FROM UPPER PIT RIVER AND TRIBUTARIES

Source	Name	Crop acreage										
		Meadow hay	Grain hay and meadow hay	Alfalfa and meadow hay	Alfalfa	Grain	Meadow pasture	Pasture	Grain hay	Orchard	Garden	Total
Hot Springs Valley Area, Continued												
Thomas and Raker Reservoir and Swanson Reservoir.	S. B. Graham	59.1			29.2							88.3
	L. and J. H. McHugh					37.3						37.3
	E. Swanson				11.3	34.8						46.1
	W. B. Chambers					9.7						9.7
	Goldie Leonard	158.8										158.8
	A. W. Toreson				22.7							22.7
	(No name)				22.8						1.5	24.3
	Frank McArthur					17.5						17.5
	A. Thomas				102.0							102.0
	L. Smith				59.0							59.0
	Veterans Welfare Board				85.0	52.0						137.0
	Town of Alturas				86.0							86.0
	J. Thomas				24.0							24.0
Big Sage Reservoir (Rattlesnake Creek.)	Spicer Co.	280.0			35.0	9.0		75.0				399.0
	Pickering Lumber Co.							39.0				39.0
	J. M. Clark	16.0									6.0	22.0
	Hoy and Christen	4.0			3.0							7.0
	J. W. Cummings Estate					10.0					7.0	17.0
	S. B. and B. L. Kelley				35.0	6.0					2.0	43.0
	S. B. Kelley				4.0							4.0
	Dora H. Kelley				82.0							82.0
	A. H. Layton										1.0	1.0
	T. W. Lush				15.0							15.0
	M. L. Raker	2.5										2.5
	W. J. and P. S. Dorris											400.0
Pit River and Big Sage Reservoir.	Hoy and Christen	68.0			64.0			51.0				183.0
	J. W. Cummings Estate	42.0			13.0							55.0
	A. H. Layton	3.0			29.0							32.0
	Mary O. Layton										3.0	3.0
	John Lybarger				16.0							16.0
	McBrien Est. and McConnel Est.	209.0										209.0
	G. C. Lindauer	606.0			134.0							740.0
	J. H. Edwards	44.0										44.0
	Frank McArthur	618.0			4.0							622.0

	John Kelley	12.0										12.0
	Margaret Essex	65.0										65.0
	V. C. Hastings	47.0										47.0
	Gus Meckfessel	45.7										45.7
	Bank of Modoc County	65.0										65.0
	Ned Chambers	73.0			58.0							131.0
	A. M. Green	154.0						10.0				164.0
	I. N. Hulbert	162.8						228.0				390.8
	Ira Hulbert	22.7										22.7
	A. Connelly	169.0				15.0						184.0
	J. M. Fitzhugh	278.0						4.0				282.0
	G. L. Kramer	189.0										189.0
	Indian allotment	4.0										4.0
	F. W. Caldwell	176.0										176.0
	M. Goch Estate (Hughes)	89.0										89.0
	Federal Land Bank of Berkeley	53.0										53.0
	Lizzie Pope	64.0										64.0
Clover Swale	Huffman and Blasingame	230.2									1.5	231.7
	E. T. Walcott	404.4						216.3				620.7
	Open Land (Huffman)	5.6										5.6
	J. S. Potter	325.0			27.0			22.0				374.0
	A. M. Green	229.1										229.1
	Margaret Essex							65.9				65.9
	Modoc County							22.5				22.5
Black Canyon	J. S. Potter	269.0			51.0							320.0
Howard Gulch	J. J. Caldwell	33.2										33.2
	J. V. Caldwell Estate (open land)	18.2										18.2
Rye Grass Swale	Wm. Scott			83.4								83.4
	Wm. B. Graves					194.4					0.5	194.9
Canyon Creek	R. H. Wells	77.0				5.7					1.4	84.1
	D. P. Brown	3.1									0.2	3.3
	First National Bank of Alturas	85.1										85.1
	Arthur Essex	220.5										220.5
	J. M. Brown and John Ivory	436.6										436.6
	G. C. Lindauer	42.4										42.4
Toms Creek	Dora K. Marlett	71.0						17.0		5.0	6.0	99.0
	G. L. Kramer	118.7						37.3			2.5	158.5
	F. W. Caldwell	243.9			133.8							377.7
Springs	J. C. Essex	153.1			7.2						1.8	162.1
	E. E. Caldwell	290.1										290.1
	J. M. Fitzhugh	206.0										206.0
	Open land (Fitzhugh)	5.0										5.0
	T. L. and C. M. Chambers							48.4				48.4
	S. N. Toreson	105.3									1.0	106.3
	Hot Spring Valley Irrigation District	3.0										3.0
	United States Forest Service	7.3										7.3

TABLE 48—Continued

ACREAGE IRRIGATED FROM UPPER PIT RIVER AND TRIBUTARIES

Source	Name	Crop acreage										
		Meadow hay	Grain hay and meadow hay	Alfalfa and meadow hay	Alfalfa	Grain	Meadow pasture	Pasture	Grain hay	Orchard	Garden	Total
Big Valley Area												
Turner Creek	First National Bank of Alturas	52.1										52.1
	E. E. Caldwell	33.7										33.7
	Open land (Caldwell)	2.0										2.0
Pit River	Dorris Eades				*71.9	*17.8	*6.5					96.2
	Mrs. E. Kasper et al.				*3.2	*16.1						19.3
	A. Criss				*48.3	*5.6	*1.5					55.4
	O. J. Gould						17.8				*9.7	27.5
	O. J. Gould				*89.1							89.1
	Mrs. E. M. Hines				*63.9							63.9
	A. Gould				*86.9							86.9
	J. E. Kresge					*40.5						40.5
	Willis Joiner				61.6						4.3	65.9
	Francis Miller						4.1					4.1
	F. C. Robinson				*91.5	*31.6					0.5	123.6
	L. A. Monchamp			*20.3	*92.4	*8.2						120.9
	H. M. Roberts				*226.0							226.0
	Wm. Kramer				*427.2	*33.0						460.2
	Joseph Andrews				*287.0							287.0
	Town of Lookout				*4.0							4.0
	Ralph D. and Truman A. Oilar	652.0			*38.0			110.0				800.0
	J. W. Leventon			*160.0								160.0
	A. and T. Thrasher				*91.0							91.0
	D. M. Courtright				*76.0							76.0
	J. J. Potter				*14.0							14.0
	C. R. Brown				*165.0							165.0
	J. W. and E. Stevenson				*54.0	*227.0						281.0
	G. W. Harvey			21.0	*73.0							94.0
	A. G. and Gertrude Eades				*33.0							33.0
	A. L. Hayes				*269.0							269.0
	Frank M. Blair			*32.0	*46.0							78.0
	W. H. Gerig	197.0			*4.0							201.0

												0
	G. L. Kramer	449 0			*78 0							527 0
	Peter Gerig	264 0						61 0				325 0
	James H. Hollenbeak	240 0		176 0	*16 0							432 0
	J. H. Holl	355 0			*66 0		52 0					473.0
	A. Pireen				3 0							3.0
	H. C. Watson	61 0										61.0
	John Wallson	119 0										119.0
	A. C. Sehow	36 0										36 0
	Lester A. Babcock				157 7							157 7
	Ernest E. Babcock	29 0		40 0	202 9						3 0	274 9
	Marjorie Merritt	440 6						32 4				473 0
	Homer Jack				176 5	7 3						183.8
	Mary Hollenbeak	115 0										115.0
	C. W. Gerig		320 0									320 0
	A. E. deMange	176 0										176 0
	Alva A. Kardoff	15 2										15 2
	Dolly Knox	180.0										180.0
	Dan Fox	146 0										146 0
	R. McArthur	794.0										794 0
	Peter Krag Company	254 0					87 0					341 0
	Andrew Babcock	137 0	200 0		140 1							477.1
	A. F. Babcock	160 0										160 0
	Antone Avilla	786 0										786 0
	Babcock Brothers	171.0										171 0
	Henry Wool (Jones)	132 0										132 0
	Bob and Sarah Wolfin	31 0										31 0
	Open land NW¼ NW¼ Sec. 11, T. 37 N., R. 7 E.	7 0										7 0
	Clara Bieber	0 3										0 3
	Elmer A. Jones et al.	90 0						164 9				254 9
	W. L. Campbell	40 0										40 0
	L. W. Campbell	0 5										0 5
	A. F. Neasham	1 6										1 6
	G. S. Thompson	77 0			2 0							79 0
	Milton Babcock										1 0	1 0
Taylor Creek	G. L. Kramer											795 0
	F. H. Roberts											115 0
	R. L. Nichols	219.5										219 5
Widow Valley Creek	L. E. Vickers	100 0									3 2	103 2
	G. Anderson	5 5										5 5
	A. D. Miller							6 8				6.8
	G. L. Kramer	704 4						7 2				711 6
Jumper Creek	Nels Iverson	48 6						140 1				188 7
	Open land (Iverson)	49 4										49 4

TABLE 48 Continued

ACREAGE IRRIGATED FROM UPPER PIT RIVER AND TRIBUTARIES

Source	Name	Crop acreage										
		Meadow hay	Grain hay and meadow hay	Alfalfa and meadow hay	Alfalfa	Grain	Meadow pasture	Pasture	Grain hay	Orchard	Garden	Total
Ash Creek Area												
Ash Creek	J. J. and Ora Fleming	818.8										818.8
	Open Land	8.6										8.6
	Mary A. Bath et al.	384.0										384.0
	Wm. A. Loveland	220.8						36.7				257.5
	J. F. Bath Estate	197.2										197.2
	J. H. Fulstone	230.8						25.9				256.7
	J. F. Bath Estate and J. H. Fulstone	142.2										142.2
	Eltha A. Perkins	263.3										263.3
	T. A. Barrows	311.1										311.1
	A. J. Kresge				1.0							1.0
	A. J. Kresge	57.5				8.1					0.4	66.0
	Mary E. Harbert	49.5										49.5
	J. A. Clark	42.9					26.7					69.6
	W. E. Clark	35.6		21.9	38.1		2.9	2.1				100.6
	M. E. Harbert	1.8			9.7			3.5				15.0
	V. M. Roseberry, et al.	84.2					8.3					92.5
	Open Land	44.0										44.0
	J. H. Vogt	160.2			43.7	100.3	6.5	3.5	14.5			338.7
	C. W. Clarke Company				95.6		478.8	4,424.0	452.0			5,450.4
	A. J. Meeks							93.2				93.2
	Indian Allotment	39.0					2.3					41.3
	J. C. Lane	100.4				178.2						278.6
	Levi A. James	120.0					29.2					149.2
	Jessie A. Chisholm	38.9										38.9
	Millie M. Steiger	94.0				45.8	25.9	26.7	26.8			219.2
	Alice M. Wayman	263.2										263.2
	H. C. Watson				8.2	16.9						25.1
	John Miller	175.0			72.1	64.8	14.4				1.0	327.3
	Kasper Weigand	129.0			82.6		12.1					223.7
	A. L. Cannon	76.1					88.0					164.1
	J. Andrews						17.8					17.8
	Wm. Kramer	44.0										44.0
	Lulu Davidson	161.2					2.2	33.2				196.6
	C. A. and Elsie Gerig	165.2					33.4	3.1				201.7
	Charles M. Leonard				110.0			4.7			7.2	121.9
	Clara Bieber				19.4							19.4

	Arthur Kenyon				133.7							133.7
	A. F. Babcock				119.1	23.5		9.1			2.0	153.7
	Milton Babcock				69.7			47.8				117.5
Rush Creek	T. J. Rice	21.1										21.1
	J. T. Steele	22.7			1.4			2.8		0.5	1.1	28.5
	W. D. McCleure										13.8	13.8
	W. C. and A. L. Akins							1.1			1.2	2.3
	C. A. Higgins	13.0				14.0				7.3	2.0	36.3
	M. A. Rice	43.9		21.9								65.8
	T. J. Rice							15.0				15.0
	N. S. and Laura A. Kresge	29.0										29.0
	John Holbrook		125.6								2.0	127.6
Willow Creek	Nancy Owens	8.0				63.0	20.0					91.0
	A. E. and L. Armstrong			17.8								17.8
	F. F. Walker	71.2										71.2
	S. E. Knight	362.9										362.9
	Frank Studley	328.9				16.5		8.4				353.8
	Kasper Weigand	153.1										153.1
	Park N. Johnson Estate	50.2										50.2
	M. E. Crom et al.	89.1					11.0					100.1
Butte Creek	Herbert S. Bath	53.5										53.5
	Myrtle Niles			47.5								47.5
	Ivy Auble	55.9										55.9
	S. J. and Myrtle Niles	58.3										58.3
	Open Land (Niles)	1.2										1.2
	Maud S. Finney	44.6			6.0			42.0				92.6
Horse Creek Area												
Horse Creek	W. C. Clarke Co.	1,258.6										1,258.6
	Open Land	28.0										28.0
	Open Land	4.0										4.0
	Open Land	12.0										12.0
	Open Land	6.0										6.0
	Indian Allotment	30.0										30.0
	Open Land (Bognuda)	7.0										7.0
	Open Land (Bognuda)	5.1										5.1
	Ned Bognuda	360.0									0.5	360.5

*Subirrigated land.
[a] Receive supplemental water from North and South Forks of Pit River and from Parker Creek and Stockdill Slough through the Dorris Reservoir.

TABLE 49

SUMMARY OF ACREAGE IRRIGATED FROM UPPER PIT RIVER AND TRIBUTARIES

Source	Crop acreage											
	Meadow hay	Grain hay and meadow hay	Alfalfa and meadow hay	Alfalfa	Grain	Meadow pasture	Pasture	Grain hay	Orchard	Garden	Unclassified	Total
East Creek	1,154.5			8.1		54.8	686.1		0.4	3.7		1,907.6
Mill Creek	531.4			12.0	4.2	219.9	235.6		1.6	3.9		1,008.6
Soup Creek	60.5				4.3		21.0			1.3		87.1
Harvey Creek	643.3						34.0					677.3
Coyote Creek							151.5					151.5
Parsnip Creek							123.8					123.8
West Valley Creek	477.6				21.9		80.8			3.4		583.7
Crooks Canyon	160.0											160.0
Fitzhugh Creek	506.0			405.6		139.0	233.4		1.0	2.9		1,287.9
South Fork Pit River	13,315.0		163.7	358.3	785.7	87.5	493.2			8.1		15,211.5
Pine Creek	4,284.5			508.4	474.9	85.4	292.6			13.2		5,659.0
Linville Creek	528.1			26.0		63.5	26.7		7.8	1.2		653.3
Franklin Creek	697.7			43.0	38.3	67.2	42.7		13.3	7.1		909.3
Thoms Creek	105.8	34.0	51.3	15.4	66.6				1.5	7.9		282.5
Joseph Creek	448.1					94.1	148.4			0.7		691.3
Parker Creek	220.3		163.5	31.6	87.1	25.8				1.0	1,580.0	2,109.3
Mud Lake Reservoir					17.0							17.0
North Fork Pit River	746.3		91.1	1,090.9	701.6	1.6	65.6		8.1	3.2		2,708.4
Thomas and Baker Reservoir	217.9			442.0	151.3					1.5		812.7
Pit River							116.0					116.0
Big Sage Reservoir and Rattlesnake Creek	302.5			174.0	25.0		114.0			16.0	400.0	1,031.5
Big Sage Reservoir and Pit River	3,259.2			318.0	15.0		293.0			3.0		3,888.2
Rye Grass Swale			83.4		194.4					0.5		278.3
Canyon Creek	864.7				5.7					1.6		872.0
Toms Creek	433.6			133.8			54.3		5.0	8.5		635.2
Clover Swale	1,194.3			27.0			326.7			1.5		1,549.5
Black Canyon	269.0			51.0								320.0
Howard Gulch	51.4											51.4
Springs	769.8			7.2			48.4			2.8		828.2
Turner Creek	87.6											87.6
Pit River Big Valley	6,156.4	520.0	449.3	3,258.2	387.1	168.9	368.3			18.5		11,414.3
Ash Creek	4,458.5		21.9	802.9	447.6	748.5	4,713.5	493.3		10.6		11,696.8
Rush Creek	129.7	125.6	21.9	1.4	14.0		18.9		7.8	20.1		339.4
Butte Creek	213.5		47.5	6.0			42.0					309.0
Willow Creek	1,063.4		17.8		79.5	31.0	8.4					1,200.1
Juniper Creek	98.0						140.1					238.1
Widow Valley Creek	809.9						14.0			3.2		827.1
Taylor Creek	219.5										910.0	1,129.5
Horse Creek	1,710.7									0.5		1,711.2
Totals	46,188.7	679.6	1,111.4	7,720.8	3,521.2	1,787.2	8,893.0	493.3	46.5	145.9	2,890.0	73,477.6

TABLE 50

DISCHARGE MEASUREMENTS OF DIVERSIONS, UPPER PIT RIVER AND TRIBUTARIES

Sources Listed in Their Order Downstream

Diversions From Each Source Arranged Alphabetically

Source	Name of ditch	Location of point of measurement	Gage height, feet	Discharge c. f. s.	Date
North Fork Pit River	Bettandorf	At head		1.36	7/3/29
	Bettandorf	At head	2.60	1.42	4/16/30
	Bettandorf	At head	2.07	.43	5/1/30
	Bettandorf	At head		.10	4/9/31
	Laird North from P. R. D. & D. Co.	At division point		5.21	5/21/29
	Lauer	At head		1.28	9/17/29
	Lauer	At head		4.49	3/13/31
	Lauer	At head		2.30	3/31/31
	Lauer	At head		.54	5/14/31
	Lauer	Near Alturas		[a]1.4	8/27/04
	Lauer	At N. L. Ranch		[a]1.42	5/23/05
	Lauer South from P. R. D. & D. Co.	At division point		7.65	5/21/29
	Laver Flume P. R. D. & D. Co.	At river crossing	4.28	3.15	5/11/30
	Laver Flume P. R. D. & D. Co.	At river crossing	4.57	5.94	5/11/30
	Laver Flume P. R. D. & D. Co.	At river crossing	4.60	6.48	5/11/30
	Laver Flume P. R. D. & D. Co.	At river crossing		.75	4/24/31
	Pit River Dam & Ditch Co.	At head		16.51	5/2/29
	Pit River Dam & Ditch Co.	At head		2.41	6/19/29
	Pit River Dam & Ditch Co.	At head		1.75	7/3/29
	Pit River Dam & Ditch Co.	At head	2.44	8.15	4/16/30
	Pit River Dam & Ditch Co.	At head	2.19	4.00	5/1/30
	Pit River Dam & Ditch Co.	At head		3.99	3/12/31
	Pit River Dam & Ditch Co.	At head		5.99	3/27/31
	Pit River Dam & Ditch Co.	At head		4.54	4/10/31
	Pit River Dam & Ditch Co.	At head		4.46	4/18/31
	Pit River Dam & Ditch Co.	At head		3.61	5/14/31
	Pit River Dam & Ditch Co.	100 ft. below concrete flume		6.94	3/27/31
	N. L.	At head		6.98	3/31/31
	N. L.	At head		.10	5/15/31
Joseph Creek	Freeman-Kipp-McElwain	At head		2.84	5/13/30
	Freeman-Kipp-McElwain	At head		2.20	6/9/30
	Freeman-Kipp-McElwain	At head		.60	9/5/30
	Freeman-Kipp-McElwain	At McElwain house		1.41	7/1/30
	Freeman & Kipp	At head		.42	5/13/30
	Freeman & Kipp	At head		.32	6/9/30
	Robnett	At head		3.45	5/13/30
	Robnett	At head		1.58	6/9/30
	Wilson Lower	At head		.83	6/9/30
	Wilson Lower	At head		.25	8/5/30
	N. L.	At head		.55	5/13/30
	N. L.	At head		.39	6/9/30
Couch Creek	Espil Upper	At head		.84	5/13/30
	Espil Upper	At head		.52	6/9/30
	Espil Middle	At head		.87	5/13/30
	Espil Middle	At head		.32	6/9/30
	Espil Lower	At head		1.20	5/13/30
	Espil Lower	At head		.45	6/9/30
Thoms Creek	Baker Upper	At head		.00	7/1/30
	Baker Upper	At head		.20	4/1/31
	DeWitt Upper Left	At head		1.69	6/11/30
	DeWitt Upper Left	At head		1.32	6/26/30
	DeWitt Upper Left	At highway crossing		.70	6/26/30
	Hayes Upper Left	At head		.20	6/26/30
	Hayes Upper Left	At head		.02	9/5/30
	Hayes Upper Right	At head		.88	6/26/30
	Hayes Lower Left	At head		.64	6/26/30
	Hayes Middle Right	At head		5.04	6/26/30
	Hayes Lower Right	At head		1.00	6/26/30
	Head	At divide		.015	6/26/30
	Renner Upper Right	At head		.70	7/1/30
	Royce, Dan-Upper	At head		.40	6/30/30
	Royce, Dan-Lower	At head		.57	7/1/30
	Royce, Joseph	At head		.31	6/30/30
	Stiner Upper	At head		.73	6/30/30
	Stiner Lower	At head		.54	6/30/30
	Wilson (Jones) Upper	At head		1.03	6/11/30

TABLE 50—Continued

DISCHARGE MEASUREMENTS OF DIVERSIONS, UPPER PIT RIVER AND TRIBUTARIES

Source	Name of ditch	Location of point of measurement	Gage height, feet	Discharge c. f. s.	Date
Thoms Creek, Cont.	Wilson (Jones) Upper	At head		.84	6/26/30
	Wilson (Jones) Upper	At head		.20	9/5/30
	Wilson (Jones) Upper	At head		.20	7/1/31
	Wilson (Jones) Lower	At head		.39	6/11/30
	Wilson (Jones) Lower	At head		.38	6/26/30
Bowlin Creek	DeWitt Upper Right	At head		.00	6/11/30
	DeWitt Upper Right	At head		.00	6/26/30
	DeWitt Middle Right	At head		.00	6/11/30
	DeWitt Middle Right	At head		.00	6/26/30
	DeWitt Upper Left	At head		.23	6/11/30
	DeWitt Upper Left	At head		.25	6/26/30
	DeWitt Lower Left	At head		.03	6/26/30
	DeWitt Lower Right	At head		.94	6/11/30
	DeWitt Lower Right	Opposite DeWitt house		.20	6/26/30
Mile Creek	Hayes	At head		.17	6/26/30
	Royce, Hugh	At head		.02	9/5/30
Parker Creek	Dorris Reservoir	At head		47.37	4/19/29
	Dorris Reservoir	At divide	1.32	40.88	3/19/30
	Dorris Reservoir	At divide	1.56	47.99	3/28/30
	Dorris Reservoir	At divide	.94	19.16	4/8/30
	Dorris Reservoir	At divide	.55	6.93	4/8/30
	Dorris Reservoir	At divide	.28	1.88	3/7/31
	Dorris Reservoir	At divide	.22	7.50	3/20/31
	Dorris Reservoir	At divide	.24	8.10	3/27/31
	Dorris Reservoir	At divide	.25	8.40	4/3/31
	Fogarty Garden	At head		.09	8/6/31
	Fogarty Garden	At head		.07	8/12/31
	Fogarty Garden	At head		.09	8/26/31
	Fogarty-Porter	At head		4.52	5/12/30
	Fogarty-Porter	At head		1.95	6/25/30
	Fogarty-Porter	At head		.00	9/3/30
	Fogarty-Porter	Above Fogarty house		1.74	4/14/31
	Fogarty-Porter	2 miles below head		1.11	3/23/30
	Fogarty-Porter	2 miles below head		1.84	5/12/30
	Payne Upper	At head		.97	5/6/30
	Payne Upper	At head		.00	5/23/30
	Payne Upper	At head		.94	6/13/30
	Payne Upper	At head		.15	9/3/30
	Payne Upper	At head		.20	8/10/31
	Payne Upper	At head		.20	8/12/31
	Payne Middle	At head		12.44	5/6/30
	Payne Lower	At head		15.41	5/23/30
	Payne Lower	At head		4.88	6/13/30
	Porter, Alice	At head		1.95	5/26/30
	Porter, Alice	At head		2.36	6/20/30
	Porter, Alice	At head		.48	6/23/30
	Porter, Alice	At head		5.71	5/7/30
	Porter, Alice	At head		2.10	5/26/30
	Porter, Alice	At head		5.04	6/20/30
	Porter, Alice	At head		.91	6/23/30
	Porter, Alice	At head		.49	5/26/30
	Porter, Alice, James & Pearl	At head		11.04	5/7/30
	Porter, Alice, James & Pearl	At head		6.76	5/26/30
	Porter, Alice, James & Pearl	At head		2.95	5/26/30
	Porter, Alice, James & Pearl	At head		4.23	6/23/30
	Porter, James, Upper	At county road		.15	3/7/31
	Porter, James & N. L. Ranch	At head		19.15	5/7/30
	Porter, James & N. L. Ranch	At head		3.60	5/26/30
	Porter, James & N. L. Ranch	At head		2.71	6/23/30
	Porter, Pearl	At head		2.92	5/7/30
	Porter, Pearl	At head		1.09	5/26/30
	Porter, Pearl	At head		.24	6/20/30
	Porter, Pearl	At head		.67	6/23/30
	Stanton	At head		5.69	5/12/30
	Stanton	At head		2.92	6/18/30
	Stanton	At head		.74	7/8/30
	Stanton	At head		.00	9/3/30
	Stanton	At head		6.36	4/14/31
	Trumbo Upper	At head		3.09	5/12/30
	Trumbo Upper	At head		2.19	6/18/30
	Trumbo Lower	At head		3.23	5/12/30
	Trumbo Lower	At head		2.61	6/18/30
	Trumbo Lower	At head		.76	4/14/31

TABLE 50—Continued

DISCHARGE MEASUREMENTS OF DIVERSIONS, UPPER PIT RIVER AND TRIBUTARIES

Source	Name of ditch	Location of point of measurement	Gage height, feet	Discharge c. f. s.	Date
Shields Creek	McDowell Upper	At head		.81	4/ 9/31
	McDowell Lower	At head		1.58	5/ 6/30
	McDowell Lower	At head		1.92	6/ 5/30
	McDowell Lower	At head		.21	8/12/31
	McDowell Lower	At head		.11	8/20/31
	McDowell Lower	At head		.21	9/14/31
	Page	At head		.00	5/ 6/30
	Page	At head		5.67	5/12/30
	Page	At head		3.15	6/18/30
	Page	At head		3.46	6/25/30
	Page	At head		.78	9/ 3/30
	Page	At head		.00	4/14/31
	Page	At head		.09	8/ 6/31
	Page	At head		.09	8/12/31
	Porter, Alice	At head		1.09	5/ 6/30
	Porter, Alice	At reservoir		.06	9/ 3/30
	Trumbo Upper	Near head		4.83	5/ 6/30
	Trumbo Upper	Near head		5.08	5/12/30
	Trumbo Upper	Near head		1.52	6/ 5/30
	Trumbo Upper	Near head		.25	9/ 3/30
	Trumbo Middle	Near head		3.41	5/12/30
	Trumbo Middle	Near head		.93	6/ 5/30
	Trumbo Middle	Near head		.25	9/ 3/30
South Fork Pit River	Corporation	2 miles east of Likely		[a]23	6/ 7/05
	Corporation	2 miles east of Likely		[a]24	6/20/05
	Corporation	2 miles east of Likely		[a]29	9/ 6/05
	Corporation	At head		6.62	5/29/31
	Corporation	At head		1.20	8/ 1/31
	Corporation	At head		1.20	8/13/31
	Corporation	At head		1.20	8/14/31
	Corporation	At head		1.20	8/21/31
	Corporation	At head		1.00	8/24/31
	Corporation	At head		.30	8/26/31
	Corporation	At head		3.75	8/29/31
	Corporation	At head		1.05	8/31/31
	Corporation	At head		1.30	9/ 3/31
	Corporation	At head		1.40	9/ 5/31
	Corporation	At head		1.20	9/10/31
	Corpo!ation	At head		1.20	9/14/31
	Corporation	At head		1.65	9/17/31
	Corporation	At head		1.60	9/21/31
	Corporation	At head		2.10	9/24/31
	Corporation	At head		2.00	9/26/31
	Corporation	At head		1.80	9/29/31
	Corporation	Near Likely		[a]30	9/17/04
	Corporation	Above county road crossing		18.38	5/14/29
	Corporation	Above county road crossing	1.40	8.17	3/18/30
	Corporation	Above county road crossing	.92	3.22	4/ 4/30
	Corporation	Above county road crossing	1.70	10.2	4/17/30
	Corporation	Above county road crossing	1.92	12.5	4/21/30
	Corporation	Above county road crossing	2.51	6.17	6/24/30
	Corporation	Above county road crossing	2.10	19.39	4/ 6/31
	Corporation	Above county road crossing	1.36	5.98	5/29/31
	Corporation	Above county road crossing	1.17	3.15	6/ 7/31
	Corporation	Above county road crossing	1.50	2.91	6/24/31
	East Side Canal	At head	1.50	63.1	4/18/31
	East Side Canal	At head	.78	40	4/25/30
	East Side Canal	At head	.86	42.6	5/19/30
	East Side Canal	At head	—.75	.44	6/17/30
	East Side Canal	At head	—.85	.25	6/24/30
	East Side Canal	At head		*.10	4/18/31
	East Side Canal	At head		.55	6/ 1/31
	East Side Canal	At head		*.10	6/24/31
	East Side Canal	At head		2.45	8/ 1/31
	East Side Canal	At head		1.00	8/24/31
	East Side Canal	At head		2.15	8/31/31
	East Side Canal	At head		2.50	9/ 1/31

TABLE 50—Continued

DISCHARGE MEASUREMENTS OF DIVERSIONS, UPPER PIT RIVER AND TRIBUTARIES

Source	Name of ditch	Location of point of measurement	Gage height, feet	Discharge c. f. s.	Date
South Fork Pit River, Continued	East Side Canal	At head		.45	9/3/31
	East Side Canal	At head		1.35	9/5/31
	East Side Canal	At head		1.20	9/10/31
	East Side Canal	At head		1.40	9/14/31
	East Side Canal	At head		1.75	9/17/31
	East Side Canal	At head		2.00	9/24/31
	East Side Canal	At head		.30	9/26/31
	East Side Canal	At head		1.10	9/29/31
	Flournoy	At head	.70	5.84	4/18/30
	Flournoy	At head	.00	.00	4/28/30
	Flournoy	At head	1.64	13.87	5/20/30
	Flournoy	At head	1.39	6.44	6/17/30
	Flournoy	At head	1.44	7.20	6/24/30
	Flournoy	At head		2.00	4/18/31
	Flournoy	At head		4.7	5/17/31
	Flournoy	At head		1.64	5/30/31
	Flournoy	At head	.40	.49	6/8/31
	Flournoy	At head	.64	1.08	6/24/31
	Flournoy	At head	.14	.54	8/1/31
	Flournoy	At head	.32	.72	8/18/31
	Flournoy	At head	.57	1.76	8/19/31
	Flournoy	At head		1.80	8/24/31
	Flournoy	At head		.50	8/29/31
	Flournoy	At head		1.90	8/31/31
	Flournoy	At head		1.60	9/3/31
	Flournoy	At head		1.90	9/5/31
	Flournoy	At head		1.30	9/10/31
	Flournoy	At head		1.50	9/14/31
	Flournoy	At head		1.50	9/17/31
	Flournoy	At head		1.60	9/24/31
	Flournoy	At head		1.76	9/26/31
	Flournoy	At head		2.10	9/29/31
	Jackson (Granstad)	At head		[a]6.9	6/8/05
	Jackson (Granstad)	At head		[a]8.7	7/2/05
	Jackson	At head	1.30	7.96	4/21/30
	Jackson	At head	.96	4.51	5/19/30
	Jackson	At head	1.18	6.25	6/4/30
	Jackson	At head		5.84	4/16/31
	Jackson	At head		3.70	5/29/31
	Jackson	At head		2.39	6/8/31
	Jackson	At head		2.64	6/24/31
	Jackson	At head		1.50	8/1/31
	Jackson	At head		.63	8/13/31
	Jackson	At head		.63	8/14/31
	Jackson	At head		.90	8/24/31
	Jackson	At head		.80	8/29/31
	Jackson	At head		1.05	8/31/31
	Jackson	At head		1.20	9/3/31
	Jackson	At head		1.40	9/5/31
	Jackson	At head		.70	9/10/31
	Jackson	At head		1.00	9/14/31
	Jackson	At head		1.50	9/17/31
	Jackson	At head		1.35	9/21/31
	Jackson	At head		1.60	9/24/31
	Jackson	At head		1.60	9/26/31
	Jackson	At head		.50	9/29/31
	Masters	At head		4.31	5/29/31
	Masters	At head		2.00	8/1/31
	Masters (Dukes)	Below long flume		[a]3.3	9/17/04
	Masters (Dukes)	Below long flume		[a]8.7	9/23/04
	Masters (Dukes)	Below long flume		[a]13.9	6/7/05
	Masters (Dukes)	Below long flume		[a]9.8	6/20/05
	Masters	Below long flume		10.63	5/14/29
	Masters	Below long flume		7.05	6/29/29
	Masters	Below long flume	1.07	3.77	4/6/31
	Masters	Below long flume	1.17	3.56	4/18/31
	Masters	Below long flume		3.68	5/29/31
	Masters	Below long flume		1.02	6/8/31
	Masters	Below long flume		2.50	6/24/31
	Masters	Below lower flume		1.50	8/14/31
	Masters	Below lower flume		1.20	8/21/31
	Masters	Below lower flume		.90	8/24/31
	Masters	Below lower flume		.40	8/29/31
	Masters	Below lower flume		1.75	8/31/31
	Masters	Below lower flume		2.20	9/3/31
	Masters	Below lower flume		1.60	9/5/31

TABLE 50—Continued

DISCHARGE MEASUREMENTS OF DIVERSIONS, UPPER PIT RIVER AND TRIBUTARIES

Source	Name of ditch	Location of point of measurement	Gage height, feet	Discharge c. f. s.	Date
South Fork Pit River, Continued	Masters	Below lower flume		.90	9/10/31
	Masters	Below lower flume		.80	9/14/31
	Masters	Below lower flume		.85	9/17/31
	Masters	Below lower flume		1.30	9/21/31
	Masters	Below lower flume		1.40	9/24/31
	Masters	Below lower flume		1.40	9/26/31
	Masters	Below lower flume		.00	9/29/31
	Masters	At Roy Williams house	1.12	4.78	4/18/30
	Masters	At Roy Williams house	1.56	10.93	4/21/30
	Masters	At Roy Williams house	1.75	11.29	5/19/30
	Masters	At Roy Williams house	1.54	7.07	6/24/30
	Van Loan	At head		[a].35	6/8/05
	Van Loan	At head		[a].25	6/20/05
	Van Loan	At head	2.42	48.92	4/30/30
	Van Loan	At head	2.11	40.45	6/4/30
	Van Loan	At head	1.25	15.38	6/17/30
	Van Loan	At head		9.64	4/6/31
	Van Loan	At head	.71	5.21	5/30/31
	Van Loan	At head	.86	5.66	6/7/31
	Van Loan	At head	.94	3.81	6/24/31
	Van Loan	At head	.65	1.06	8/1/31
	Van Loan	At head		1.00	8/13/31
	Van Loan	At head		1.00	8/14/31
	Van Loan	At head		1.60	8/21/31
	Van Loan	At head		1.40	8/24/31
	Van Loan	At head		1.00	8/29/31
	Van Loan	At head		1.60	8/31/31
	Van Loan	At head		1.60	9/3/31
	Van Loan	At head		1.50	9/5/31
	Van Loan	At head		1.50	9/10/31
	Van Loan	At head		1.30	9/14/31
	Van Loan	At head		1.60	9/17/31
	Van Loan	At head		1.60	9/21/31
	Van Loan	At head		1.60	9/24/31
	Van Loan	At head		1.80	9/26/31
	Van Loan	At head		1.60	9/29/31
	West Side Canal	At head	2.00	21.56	4/18/30
	West Side Canal	At head	2.65	64	4/28/30
	West Side Canal	At head	2.40	38.30	5/19/30
	West Side Canal	At head	1.08	6.87	6/17/30
	West Side Canal	At head	.76	3.50	6/24/30
	West Side Canal	At head	.66	2.20	9/20/30
	West Side Canal	At head		.29	4/18/31
	West Side Canal	At head		.60	8/1/31
	West Side Canal	¼ mile below head		.29	6/24/31
	West Side Canal	¼ mile below head		3.98	8/18/31
	West Side Canal	¼ mile below head	.72	2.98	8/19/31
	West Side Canal	¼ mile below head	.67	2.47	8/21/31
	West Side Canal	¼ mile below head		2.20	8/24/31
	West Side Canal	¼ mile below head		.00	8/31/31
	West Side Canal	¼ mile below head		1.95	9/3/31
	West Side Canal	¼ mile below head		1.90	9/5/31
	West Side Canal	¼ mile below head		2.60	9/10/31
	West Side Canal	¼ mile below head		2.70	9/14/31
	West Side Canal	¼ mile below head		2.50	9/17/31
	West Side Canal	¼ mile below head		2.20	9/24/31
	West Side Canal	¼ mile below head		2.80	9/26/31
	West Side Canal	¼ mile below head		2.60	9/29/31
	West Ditch from East Side Canal	At warehouse		10.37	3/4/31
Mill Creek	Big Ditch	At head		5.32	5/12/31
	Big Ditch	At head	.18	5.73	5/25/31
	Big Ditch	Below leakage	.40	3.87	5/25/31
	Big Ditch	Below leakage	.29	2.53	6/2/31
	Big Ditch	Below leakage	.21	1.60	6/22/31
	Big Ditch	Below leakage		2.26	9/5/31
	Brooks Upper	At head		.05	5/26/31
	Brooks Upper	At head		.29	6/3/31
	Brooks Upper	At head		.18	6/23/31
	Brooks Lower	At head		.38	5/26/31
	Brooks Lower	At head		.39	6/3/31
	Brooks Lower	At head		.47	6/23/31
	Brooks Upper Little Creek	At head		2.81	5/26/31
	Brooks Upper Little Creek	At head		1.99	6/3/31
	Brooks Upper Little Creek	At head		1.64	6/23/31
	Brooks Upper Little Creek	At head		2.00	8/12/31

TABLE 50 Continued

DISCHARGE MEASUREMENTS OF DIVERSIONS, UPPER PIT RIVER AND TRIBUTARIES

Source	Name of ditch	Location of point of measurement	Gage height, feet	Discharge c. f. s.	Date
Mill Creek, Continued	Brooks Lower Little Creek	At head		.48	5/26/31
	Brooks Lower Little Creek	At head		.70	6/3/31
	Brooks Lower Little Creek	At head		.24	6/23/31
	Cantrall, A. J., Upper	At head		1.89	5/12/31
	Cantrall, A. J., Upper	At head		[c]1.25	5/23/31
	Cantrall, A. J., Upper	At head	.30	1.90	5/26/31
	Cantrall, A. J., Upper	At head	.22	1.41	6/2/31
	Cantrall, A. J., Upper	At head	.17	1.00	6/22/31
	Cantrall, A. J., Middle	At head		[c].76	5/12/31
	Cantrall, A. J., Middle	At head		.50	5/26/31
	Cantrall, A. J., Middle	At head		.48	6/2/31
	Cantrall, A. J., Middle	At head		.54	6/22/31
	Cantrall, A. J., Lower	At head		2.31	5/12/31
	Cantrall, A. J., Lower	At head	.31	1.64	5/26/31
	Cantrall, A. J., Lower	At head	.26	1.29	6/2/31
	Cantrall, A. J., Lower	At head		1.37	6/22/31
	Homestead	At camp ground		1.06	5/12/31
	Homestead	At camp ground		[c]1.05	5/23/31
	Homestead	At camp ground		.67	6/2/31
	Homestead	At camp ground		.48	6/19/31
	Leoni	Near head		[c]4.38	5/23/31
	Leoni	Near head		3.12	6/2/31
	Leoni	Near head		3.05	6/19/31
	Leoni	Near head		1.90	7/7/31
	Leoni	Near head		1.23	7/28/31
	Leoni	Near head		2.57	8/10/31
	Leoni	Near head		.50	8/12/31
	Leoni	Near head		.28	8/22/31
	Leoni	Near head		2.17	9/12/31
	Leoni	At Clear Lake road crossing		1.58	8/10/31
	Old Mill	At head		2.67	5/12/31
	Old Mill	At head	.60	1.21	5/26/31
	Old Mill	At head	.50	1.04	6/2/31
	Old Mill	At head		.94	6/23/31
	Payne Mill Creek	At head		[b]1.02	8/22/24
	Payne Mill Creek	At head		[b]1.10	8/22/24
	Payne Mill Creek	At head		[b]1.00	9/29/24
	Payne Mill Creek	At head		2.30	8/5/29
	Payne Mill Creek	At head		2.49	5/28/31
	Payne Mill Creek	At head		2.44	6/30/31
	Payne Mill Creek	At divide		1.99	6/30/31
	Payne Mill Creek	At North Fork Fitzhugh Creek		1.93	8/5/29
Soup Creek (Tributary to Mill Creek)	Brooks Upper Left	At head		.45	5/27/31
	Brooks Upper Right	At head		.00	5/27/31
	Brooks Lower	At head		1.21	5/26/31
	Brooks Lower	At head		1.11	6/3/31
	Brooks Lower	At head		.11	6/23/31
	Cantrall, A. J., Upper	At head		.00	5/27/31
	Cantrall, A. J., Lower	At head		.09	5/27/31
East Creek	Campbell Garden	At head		.00	6/3/31
	Campbell Garden	At head		.00	6/4/31
	Campbell High Line	At head		.15	8/5/30
	Campbell High Line	At head		[c].97	5/22/31
	Campbell High Line	At head		1.28	6/4/31
	Campbell High Line	At head		1.09	6/22/31
	Campbell Upper Meadow	At head		[a]1.30	8/5/30
	Campbell Upper Meadow	At head		[c]3.49	5/22/31
	Campbell Upper Meadow	At head		1.67	6/4/31
	Campbell Upper Meadow	At head		3.64	6/22/31
	Campbell House	At head		[c]1.96	5/22/31
	Campbell House	At head		.91	6/4/31
	Campbell House	At head		2.50	6/22/31
	Campbell Lower Meadow	At head		[c].35	5/22/31
	Campbell Lower Meadow	At head		.32	6/4/31
	Campbell Lower Meadow	At head		.16	6/22/31
	Campbell Drain	Outlet at creek		.39	6/4/31
	Campbell Drain	Outlet at creek		1.04	6/22/31
	Campbell Drain	Outlet at creek		.76	7/7/31
	Flournoy Extension of Campbell Upper Meadow	Below Campbell fence		[c].25	5/18/31
	Flournoy Extension of Campbell Upper Meadow	Below Campbell fence		.10	6/4/31
	Flournoy Extension of Campbell Upper Meadow	Below Campbell fence		.00	6/19/31

TABLE 50—Continued

DISCHARGE MEASUREMENTS OF DIVERSIONS, UPPER PIT RIVER AND TRIBUTARIES

Source	Name of ditch	Location of point of measurement	Gage height, feet	Discharge c. f. s.	Date
East Creek—Continued	Flournoy Upper	At head		[c] .21	5/18/31
	Flournoy Upper	At head		.00	6/4/31
	Flournoy Upper	At head		[a] .10	6/19/31
	Flournoy Upper	At head		[a]Trace	7/7/31
	Flournoy Upper	At head		.40	9/19/31
	Flournoy-Spargur	At head		8.50	6/4/31
	Flournoy Corral	At head		2.00	8/15/31
	Flournoy Corral	At head		1.50	9/5/31
Harvey Creek	Flournoy	¼ mile below head		1.37	6/5/31
	Flournoy	¼ mile below head		1.16	6/25/31
	Flournoy	¼ mile below head		1.00	7/8/31
West Valley Creek	Van Loan, J.	At head		[b]12.9	8/19/24
	Van Loan, J.	At head		9.76	5/29/31
	Van Loan, J.	At head		8.63	6/8/31
	Van Loan, J.	At head		9.87	6/24/31
	Van Loan, J.	At head		7.29	7/7/31
	Van Loan, J.	At head		7.51	7/28/31
	Van Loan, J.	At head		9.06	8/15/31
	Van Loan, J.	At division point		3.80	8/15/31
	Van Loan, J.	At division point		4.40	8/21/31
	Van Loan, J.	At division point		1.00	8/31/31
	Van Loan, J.	At division point		4.55	9/10/31
Parsnip Creek (tributary West Valley Creek)	Blue Lake Ranch Upper Left	At head		.00	6/25/31
	Blue Lake Ranch Upper Right	At head		.63	6/25/31
	Blue Lake Ranch Lower Left	At head		1.85	6/25/31
	Blue Lake Ranch Lower Right	At head		1.05	6/25/31
Warm Creek (tributary West Valley Creek)	Van Loan, J.	At head		.39	5/29/31
	Van Loan, J.	At head		.28	6/24/31
	Van Loan, J.	At head		.34	7/7/31
	Van Loan, J.	At head		.09	7/28/31
Spring	S. P. Water Tank	At tank		.06	6/26/31
McGarva Spring Creek	McGarva	At head		1.08	6/27/31
Big Spring Creek	Geo. Williams Upper West	At head		1.80	6/29/31
	Geo. Williams Lower West	At head		.22	6/29/31
	Geo. Williams Upper East	At head		.67	6/29/31
	Geo. Williams Lower East	At head		1.09	6/29/31
Fitzhugh Creek	Clark	Opposite register station		.70	4/11/31
	Clark	Opposite register station		.29	6/20/31
	Payne	Near head		6.35	4/14/29
	Payne	At end of flume		.39	6/30/31
	Payne	At end of flume		.11	6/30/31
	Payne	At summit		.53	8/5/29
North Fork Fitzhugh Creek	Bowman	Head of Bowman ranch		[b]1.53	8/29/24
	Bowman	Head of Bowman ranch		[b].82	9/29/24
	Bowman	Head of Bowman ranch		[b].33	10/14/24
	Bowman	Head of Bowman ranch		1.75	8/5/29
	Bowman	Head of Bowman ranch		1.41	6/30/31
	Bowman	Outlet Bowman ranch		[b].57	9/8/24
	Bowman	Outlet Bowman ranch		[b].42	9/29/24
	Bowman	Outlet Bowman ranch		[b].39	10/14/24
	Bowman	Outlet Bowman ranch		.90	8/5/29
	Bowman	Outlet Bowman ranch		.79	6/30/31
	Yankee Jim	At head		[b].21	8/29/24
	Yankee Jim	At head		[b]1.04	9/29/24
	Yankee Jim	At head		[b]1.08	10/14/24
Pine Creek	Cantrall, L., Upper	At head		.05	8/29/30
	Cantrall, L., Lower	At head		.10	8/29/30
	Cantrall, S. A.	At tap from Pine Creek Ditch		.48	4/21/31
	Dorris Upper	At head		3.03	4/30/30
	Dorris Upper	At head		8.46	5/29/30
	Dorris Upper	At weir		2.65	4/21/31
	Dorris Lower	At head		3.03	4/30/30

TABLE 50—Continued

DISCHARGE MEASUREMENTS OF DIVERSIONS, UPPER PIT RIVER AND TRIBUTARIES

Source	Name of ditch	Location of point of measurement	Gage height, feet	Discharge c. f. s.	Date
Pine Creek—Continued	Dorris-Leoni	At head		2 00	7/9/29
	Dorris-Leoni	At head		2 57	4/30/30
	Dorris-Leoni	At head		9 04	5/29/30
	Dorris-Leoni	At head		48	8/29/30
	Dorris-Leoni	At head		1 56	4/22/31
	Dorris-Leoni	At divide	80	14 08	3/28/30
	Dorris-Leoni	At divide	78	12 40	4/1/30
	Dorris-Leoni	At divide	80	14 10	4/5/30
	Dorris-Leoni	At divide	70	8 40	4/6/30
	Dorris-Leoni	At divide	74	10 20	4/7/30
	Dorris-Leoni	At divide	55	4 22	4/8/30
	Heesch Upper	At head		1 09	6/6/30
	Heesch Upper	At head		48	4/21/31
	Pine Creek	At head		6 17	4/30/30
	Pine Creek	At head		11 60	5/29/30
	Pine Creek	At head		92	8/29/30
	Pine Creek	At head		1 42	4/21/31
	Power Diversion	At head		9 61	4/16/30
	Power Diversion	At Parshall flume	68	6 56	7/20/31
	Trumbo	At head		1.79	4/30/30
	Trumbo	At head		6 06	5/29/30
	Trumbo	At head		42	8/29/30
	Trumbo	At head		1 16	4/21/31
	Wall Upper	At head		2 81	5/29/30
	Wall Upper	At head		30	8/29/30
	Wall Upper	At head		58	4/22/31
	Wall Lower	At head		1 71	5/29/30
	Wall Lower	At head		.22	8/29/30
	Wall Lower	At head		.88	4/22/31
Pit River (Hot Springs Valley)	Chambers Pump	At pump		3 47	5/12/31
	Christen Pump	At pump		1.58	4/27/31
	Landhauer pump	At pump		4 48	6/19/31
	Landhauer Pump	At pump		5 04	6/20/31
Rattlesnake Creek	Christen Upper	At head		53	4/15/31
	Christen Lower	Near head		1 22	4/15/31
	Clark Upper	Below highway		1 45	4/15/31
	Cummins Garden (Diversions from Kelley Ditch)	At head		.21	4/15/31
	Cummins Garden	At head		.14	4/20/31
	Cummins Garden	At head		15	5/29/31
	Cummins Lower	At head		2 17	4/20/31
	Cummins Lower	At head		11	4/27/31
	Kelley Lower	At flume		1 23	4/15/30
	Kelley Diversions	Flow in 5 small take outs		40	4/27/31
	Spicer	At Spicer house		.10	4/27/31
	Kelley	In 2 ft. Parshall flume	76	4 67	4/29/30
	Kelley	200 ft. below flume	56	3 59	6/25/30
	Kelley	Below Parshall flume		4 81	4/27/31
	Kelley	3 miles below head		2 99	7/4/30
	Kelley	Above Rock Creek flume		4 38	5/29/31
	Kelley	Loss from Rock Creek flume		75	4/27/31
	Kelley	Outlet Rock Creek flume		4 28	4/27/31
	Kelley	Above Christen lower tap		3 52	5/29/31
	Kelley	Below Christen lower tap		2 49	5/29/31
	Kelley	Above Kelley taps		1 56	4/15/31
	Kelley	Above Kelley taps		5 04	4/20/31
	Kelley	Above Kelley taps		2 08	5/29/31
	Kelley	Below Kelley taps		5 03	4/20/31
	Kelley	Above Cummins tap		1 28	5/11/31
	Kelley	Above Cummins tap		1 26	5/29/31
	Kelley	Below Cummins tap		1 02	4/20/31
	Kelley	Below Cummins tap		10	5/11/31
	Kelley	Below Cummins tap		15	5/29/31
	Kelley	100 ft. below Kelley Lane		3 81	4/27/31
	Spicer Meadow Diversion	At head		12 00	4/15/31
	Spicer Meadow Diversion	At head		18 00	4/18/31
	Spicer Meadow Diversion	At head		8 41	4/19/31
	Spicer Meadow Diversion	At head		3 03	4/25/31
	Spicer Meadow Diversion	At head		4 60	5/9/31

TABLE 50—Continued

DISCHARGE MEASUREMENTS OF DIVERSIONS, UPPER PIT RIVER AND TRIBUTARIES

Source	Name of ditch	Location of point of measurement	Gage height, feet	Discharge c. f. s.	Date
Rattlesnake Creek—Continued	Spicer Meadow Diversion	At head		4.40	5/11/31
	Spicer Meadow Diversion	At head		2.00	5/27/31
	Spicer Meadow Diversion	At head		.75	5/29/31
	Spicer Meadow Diversion	At head		.50	6/4/31
	Spicer Meadow Diversion	At head		12.04	6/11/31
	Spicer Meadow Diversion	At head		2.50	6/17/31
	Spicer Meadow Diversion	At head		2.00	6/22/31
Hot Creek	East Upper	At head		.30	7/16/31
	East Lower	At head		.50	7/16/31
	West	At head		1.00	7/16/31
Canyon Creek	Essex	At head	.48	.48	6/3/30
	Wells	At head	2.60	1.17	4/3/30
	Wells	At head	2.84	2.99	4/17/30
	Wells	At head		2.24	6/3/30
	Wells	At head	2.67	1.54	6/27/30
	Wells	At head	2.64	1.40	7/3/30
	Wells	At head	2.66	1.54	8/14/30
	Wells	At head	2.63	1.48	9/6/30
	Wells	At head	2.82	2.66	4/2/31
	Wells	At head	2.66	1.29	5/18/31
Toms Creek	Caldwell Upper	At head		.31	4/14/30
	Caldwell Upper	At head		.61	6/3/30
	Caldwell Upper	At head		.46	6/27/30
	Caldwell Upper	At head		.50	4/2/31
	Caldwell Upper	At head		1.54	5/19/31
	Caldwell Middle	At head		.93	4/14/30
	Caldwell Middle	At head		3.17	6/3/30
	Caldwell Middle	At head		.58	6/27/30
	Caldwell Lower	At head		2.16	4/14/30
	Caldwell Lower	At head		1.54	6/3/30
	Caldwell Lower	At head		1.10	6/27/30
	Caldwell Lower	At head		.15	9/6/30
No Name Creek	E. E. Caldwell	Sec. 12, T. 41 N., R. 9 E.		[b].97	8/30/24
	E. E. Caldwell	Sec. 12, T. 41 N., R. 9 E.		[b]1.57	9/24/24
	E. E. Caldwell	Sec. 12, T. 41 N., R. 9 E.		[b]2.03	10/3/24
	E. E. Caldwell	Sec. 12, T. 41 N., R. 9 E.		[b]1.53	10/20/24
	E. E. Caldwell	Sec. 12, T. 41 N., R. 9 E.		[b]1.50	10/31/24
Pit River (Big Valley)	Gooch (Oilar)	Above bridge at Lookout		[a]12.00	6/13/05
	Oilar	At Lookout Dam	6.86	8.22	3/28/30
Ash Creek	Barrows Upper	At head		2.50	6/9/31
	Barrows Slough	At head		5.33	6/9/31
	Cannon	At head		3.36	9/11/29
	Cox and Clark	At Babcock intake		7.72	9/11/29
	Cox and Clark	At Babcock intake	.40	4.18	6/27/30
	Loveland	Near head		.70	7/15/29
	Loveland	At road crossing		3.72	6/8/31
	Wayman	Takeout Cox & Clark		2.73	6/27/30
Rush Creek (tributary to Ash Creek)	Rice Left	At head		.16	6/9/31
	Rice Right	At head		.83	6/9/31
Butte Creek (tributary to Ash Creek)	Bath Upper	Near head		.21	6/10/31
	Niles Upper Left	Near head		.45	6/10/31
Willow Creek (tributary to Ash Creek)	Avilla Ditches	Avilla ranch		0	6/11/31
	Armstrong	At head		0	6/11/31
	Knight	At head			
	Knight & Studley	At head		[d]4.6	6/11/31
	Knight & Studley	At Johnson ranch		.55	6/11/31

[a] Records obtained from publications of Water Resources Branch United States Geological Survey.
[b] Records of Pacific Gas and Electric Company.
[c] Measurements by W. J. Archer.
[d] Two ditches taking entire flow of Willow Creek.
[e] Discharge estimated.

APPENDIX A

AGREEMENT

BETWEEN

COUNTY OF MODOC, STATE OF CALIFORNIA

AND

DIVISION OF WATER RIGHTS, DEPARTMENT OF PUBLIC WORKS OF THE STATE OF CALIFORNIA

AGREEMENT

THIS AGREEMENT, made and entered into this 13th day of November, 1928, by and between the COUNTY OF MODOC, STATE OF CALIFORNIA, a body politic, hereinafter referred to as the party of the first part, and the DIVISION OF WATER RIGHTS, Department of Public Works of the State of California, hereinafter referred to as the party of the second part.

WITNESSETH:

WHEREAS, the party of the first part desires a comprehensive survey for the purpose of determining various factors involved in the conservation of the flood waters of Pit River and its tributaries originating in the County of Modoc, State of California;

BE IT KNOWN that the party of the first part agrees to appropriate for the purpose of financing said survey the sum of three thousand three hundred dollars ($3,300.00) during the fiscal year 1928–1929.

AND BE IT FURTHER KNOWN that said parties of the first and second part agree that the party of the second part shall execute said survey and shall have full charge, control, and direction of said survey upon the following terms and conditions, to wit:

(1) The party of the second part shall be the sole judge of the scope of the survey necessary for the purpose of determining the various factors involved in the conservation of the flood waters of the Pit River and its tributaries which originate in said Modoc County, and said party of the second part shall employ all labor, purchase all supplies, equipment, materials, etc., and have entire discretion and entire charge of said survey, its employees engaged therein, the expenditure of the money hereunder and all other matters appertaining thereto.

(2) The party of the second part will submit to said party of the first part from time to time claims upon said party of the first part for expenses incurred by the party of the second part under the provisions of this agreement, and said claims shall be due and payable to the party of the second part from time to time as such claims are submitted, and payment of such claims shall be made by the party of the first part to the party of the second part within thirty days after the submission thereof; and upon the failure of the party of the first part to make any payment within such time the party of the second part may forthwith close the survey contemplated under this agreement, and shall thereupon be released of its obligation to render the report hereinafter provided for.

(3) Payments received hereunder by the party of the second part from the party of the first part will be deposited in the State treasury to the credit of the Pit River Investigation Fund—Special—of the Division of Water Rights of the Department of Public Works of the State of California, and shall be subject to expenditure on claims presented by the party of the second part to the Department of Finance.

(4) As a part of said survey the party of the second part shall make such office studies as it deems necessary in conjunction with said work, and shall prepare and submit to the party of the first part a report embodying the data gathered under the provisions of this contract and such other relevant data as may be in the possession of the party of the second part.

(5) This agreement may be terminated by either party by serving written notice upon the other party. If so terminated by the party of the first part, then the party of the second part will be obligated to prepare and present only such report as is practicable with such funds as have been or will be made available by the party of the first part; and if terminated by the party of the second part then the party of the first part shall be entitled to a full and complete report of all data and information gathered under the provisions of this agreement.

(6) Party of the second part shall be the sole judge as to whether the survey and studies made by it under the provisions of this agreement are sufficient to satisfy the terms of this agreement, and shall be the sole judge as to whether the report submitted by it hereunder is a sufficient and proper report to satisfy the terms of this agreement.

(7) It is understood by and between the parties hereto: (1) that performance under this contract is conditioned upon the appropriation by the party of the first part of the sum hereinbefore specified for the purpose of said survey; (2) that it is the present intention and desire of the party of the first part to make further appropriations as hereinafter stated but that the party of the first part is unable at this time to definitely state what action can or will be taken by future boards of supervisors in this connection, although party of the first part realizes the importance of said work and the benefit to be derived therefrom; (3) that it will require further appropriations by said party of the first part to complete the work hereunder contemplated; (4) that party of the first part presently intends and desires that it shall appropriate for the purpose of financing said survey the sum of three thousand three hundred dollars ($3,300.00) for three consecutive years beginning with the year 1928–1929 and presently intends and desires that in case there is an unexpended balance in said appropriation at the end of any fiscal year said party of the first part will appropriate or make available the amount of said balance for use for financing said survey during the next fiscal year which amount shall be in addition to said sum of three thousand three hundred dollars ($3,300.00) which said party of the first part presently intends and desires shall be appropriated for use during each fiscal year for said three consecutive fiscal years and intends and desires that any balance remaining at the end of the third fiscal year shall be appropriated to finance the report herein provided for if said balance be needed for that purpose; and (5) that in the event that amounts presently or hereafter appropriated by the party of the first part prove inadequate to finance a complete survey, the party of the second part shall be obligated to make only such a survey and report as the funds provided for by party of the first part shall permit and that upon failure of the party of the first part to make the appropriations it presently intends and desires to make, the party of the second part may discontinue work and make such a report as funds made available by the party of the first part may permit, or may

continue work and submit such a report as said funds provided by the party of the first part may permit.

(8) All equipment that may be purchased for the work contemplated under this contract shall remain the property of the party of the second part upon the completion or termination of the survey, and studies herein provided for.

(9) It is mutually understood and agreed that this contract is to take effect on the 13th day of November, 1928.

IN WITNESS WHEREOF, the parties hereto have caused this instrument to be signed in duplicate, sealed and delivered by its proper officers duly authorized by law to do so.

COUNTY OF MODOC, STATE OF CALIFORNIA.

By J. T. NEGLEY,
Chairman of Board of Supervisors.

DIVISION OF WATER RIGHTS, DEPARTMENT OF PUBLIC WORKS, STATE OF CALIFORNIA.

By HAROLD CONKLING,
Chief of Division of Water Rights.

APPROVED:

B. B. MEEK,
Director of Department of Public Works,
State of California.

APPROVED:

ALEXANDER R. HERON,
Director of Department of Finance,
State of California.

APPENDIX B

AGREEMENT

BETWEEN

COUNTY OF LASSEN, STATE OF CALIFORNIA

AND

DIVISION OF WATER RIGHTS, DEPARTMENT OF PUBLIC WORKS OF THE STATE OF CALIFORNIA

AGREEMENT

THIS AGREEMENT, made and entered into this 14th day of November, 1928, by and between the COUNTY OF LASSEN, STATE OF CALIFORNIA, a body politic, hereinafter referred to as the party of the first part, and the DIVISION OF WATER RIGHTS, Department of Public Works of the State of California, hereinafter referred to as the party of the second part,

WITNESSETH:

WHEREAS, the party of the first part desires a comprehensive survey for the purpose of determining various factors involved in the conservation of the flood waters of Pit River and its tributaries originating in the counties of Lassen and Modoc, State of California;

BE IT KNOWN that the party of the first part agrees to appropriate for the purpose of financing said survey the sum of one thousand six hundred and fifty dollars ($1,650.00) during the fiscal year 1928–1929.

AND BE IT FURTHER KNOWN that said parties of the first and second part agree that the party of the second part shall execute said survey and shall have full charge, control, and direction of said survey upon the following terms and conditions, to wit:

(1) The party of the second part shall be the sole judge of the scope of the survey necessary for the purpose of determining the various factors involved in the conservation of the flood waters of the Pit River and its tributaries which originate in said Lassen and Modoc counties, and said party of the second part shall employ all labor, purchase all supplies, equipment, materials, etc., and have entire discretion and entire charge of said survey, its employees engaged therein, the expenditure of the money hereunder and all other matters appertaining thereto;

(2) The party of the second part will submit to said party of the first part from time to time claims upon said party of the first part for expenses incurred by the party of the second part under the provisions of this agreement, and said claims shall be due and payable to the party of the second part from time to time as such claims are submitted, and payment of such claims shall be made by the party of the first part to the party of the second part within thirty days after the submission thereof; and upon the failure of the party of the first part to make any payment within such time the party of the second part may forthwith close the survey contemplated under this agreement, and shall thereupon be released of its obligation to render the report hereinafter provided for.

(3) Payments received hereunder by the party of the second part from the party of the first part will be deposited in the State treasury to the credit of the Pit River Investigation Fund—Special—of the Division of Water Rights of the Department of Public Works of the State of California, and shall be subject to expenditure on claims presented by the party of the second part to the Department of Finance.

(4) As a part of said survey, the party of the second part shall make such office studies as it deems necessary in conjunction with said work, and shall prepare and submit to the party of the first part a

report embodying the data gathered under the provisions of this contract and such other relevant data as may be in the possession of the party of the second part.

(5) This agreement may be terminated by either party by serving written notice upon the other party. If so terminated by the party of the first part, then the party of the second part will be obligated to prepare and present only such report as is practicable with such funds as have been or will be made available by the party of the first part; and if terminated by the party of the second part then the party of the first part shall be entitled to a full and complete report of all data and information gathered under the provisions of this agreement.

(6) Party of the second part shall be the sole judge as to whether the survey and studies made by it under the provisions of this agreement are sufficient to satisfy the terms of this agreement, and shall be the sole judge as to whether the report submitted by it hereunder is a sufficient and proper report to satisfy the terms of this agreement.

(7) It is understood by and between the parties hereto: (1) that performance under this contract is conditioned upon the appropriation by the party of the first part of the sum hereinbefore specified for the purpose of said survey; (2) that it is the present intention and desire of the party of the first part to make further appropriations as hereinafter stated but that the party of the first part is unable at this time to definitely state what action can or will be taken by future boards of supervisors in this connection, although party of the first part realizes the importance of said work and the benefit to be derived therefrom; (3) that it will require further appropriations by said party of the first part to complete the work hereunder contemplated; (4) that party of the first part presently intends and desires that it shall appropriate for the purpose of financing said survey the sum of one thousand six hundred and fifty dollars ($1,650.00) for three consecutive years beginning with the year 1928–1929 and presently intends and desires that in case there is an unexpended balance in said appropriation at the end of any fiscal year said party of the first part will appropriate or make available the amount of said balance for use for financing said survey during the next fiscal year which amount shall be in addition to said sum of one thousand six hundred and fifty dollars ($1,650.00) which said party of the first part presently intends and desires shall be appropriated for use during each fiscal year for said three consecutive fiscal years and intends and desires that any balance remaining at the end of the third fiscal year shall be appropriated to finance the report herein provided for if said balance be needed for that purpose; and (5) that in the event that amounts presently or hereafter appropriated by the party of the first part prove inadequate to finance a complete survey, the party of the second part shall be obliged to make only such a survey and report as the funds provided for by party of the first part shall permit and that upon failure of the party of the first part to make the appropriations it presently intends and desires to make, the party of the second part may discontinue work and make such a report as funds made available by the party of the first part may permit, or may continue work and submit such a report as said funds provided by the party of the first part may permit.

(8) All equipment that may be purchased for the work contemplated under this contract shall remain the property of the party of the second part upon the completion or termination of the survey and studies herein provided for.

(9) It is mutually understood and agreed that this contract is to take effect on the 14th day of November, 1928.

IN WITNESS WHEREOF, the parties hereto have caused this instrument to be signed in duplicate, sealed and delivered by its proper officers duly authorized by law to do so.

COUNTY OF LASSEN, STATE OF CALIFORNIA,

By PETER GERIG,
Chairman of Board of Supervisors.

DIVISION OF WATER RIGHTS, DEPARTMENT OF PUBLIC WORKS, STATE OF CALIFORNIA,

By HAROLD CONKLING,
Chief of Division of Water Rights.

Approved:

B. B. MEEK,
Director of Department of Public Works,
State of California.

Approved:

ALEXANDER R. HERON,
Director of Department of Finance,
State of California.

APPENDIX C

GEOLOGICAL REPORT

ON

UPPER PIT RIVER DAM SITES

IN

MODOC COUNTY

By

CHESTER MARLIAVE
Engineer Geologist
November 1932

GEOLOGICAL REPORT, UPPER PIT RIVER DAM SITES

Scope of Report.

The State Division of Water Resources, under the direction of Harold Conkling, has been carrying on an investigation of the water resources of the upper Pit River. As a conclusion to the studies it was deemed advisable to outline the possibilities for storage and utilization of the run-off of the stream. Several locations were selected along the river where storage facilities seemed feasible. The writer was called upon to make a field examination of these various sites and to pass upon the suitability of them from a geological viewpoint for the location of dams.

Controlling Features.

In the case of the present upper Pit River investigation the purpose of storage is for irrigation use where only a partial development and a limited cost are the controlling factors. Another factor of major consideration, especially from a safety standpoint, is the handling of flood discharges. The hydraulic studies in this vicinity call for a spillway capable of handling a flow of about 50,000 second-feet.

Seven dam sites in all were examined, the three farthest downstream being most unfavorable on account of poor foundation conditions and lack of spillway facilities while the three upper sites offered good foundations with favorable spillway facilities but because of other economic conditions would probably exceed the allowed expenditure. Midway between these sites is another one which, from a general consideration, appears feasible and capable of falling within the allotted cost.

It should be stated that for more complete development of the run-off or for higher cost of storage that the economic features of the project would be different and that some of the other sites might be more favorable than under the present restrictions.

General Geology.

The region under consideration lies in the southwestern corner of Modoc County about 30 miles southwest of the town of Alturas. In this stretch of the Pit River its course meanders back and forth through a flow of andesite that represents the remnant of a late lava extrusion, which can be followed intermittently over the country for many miles. Beneath this andesitic flow, which has a thickness of at least 500 feet, can be seen the more extensive underlying basaltic flows of an earlier age. The quaternary alluvial deposits which are rather widely distributed over the old flat areas of basalt are not prevalent in the area under consideration as the canyon is rather narrow and at present is in the process of degradation.

Local Geology.

No attempt will be made to discuss the various sites in detail because the time spent in the field did not warrant it. It should be noted that only superficial observations were made as no exploratory work has been done at any of the proposed dam sites.

The *Eads Site* (A-A) is the lowest one examined. To obtain the required storage would require a dam about 55 feet in height above stream bed. The bedrock at this site is not in evidence, and the banks on either side of the stream channel are gradual slopes. On the right side there is a small projection but it is narrow and appears to be mantled by terrace material and to the right of this small knoll is an old flood channel which appears to be filled with a considerable depth of soft alluvium which would require an auxiliary dam structure. There are no indications of firm bedrock at the site. The general topography indicates a wide section of terraces overlain with coarse gravelly alluvium and possibly underlain by tuffaceous sediments of questionable character. Two exposures, one on the slope of the projection at the right abutment, and the other several hundred feet upstream from the left abutment, indicate that the material underlying the terraces adjacent to the channel section is composed of light colored tuffaceous sediments containing open gravels and sands. The proposed spillway is over the gentle sloping terrace of the left abutment and does not offer favorable conditions. The site in general is wide. Expensive protection to care for the enormous flood discharges will probably be necessary. From the general geological inspection this site would require deep cutoff excavations and does not warrant serious consideration as a dam site.

The *Grave Site* would require a dam height of about 60 feet. The present stream channel is about 65 feet wide. The left abutment rises rather abruptly but shows no hard bedrock outcrops, though the topography indicates that it is composed of fairly stable beds of agglomerate and tuffaceous sediments. To the right of the stream section there is a vertical bluff about 20 feet high which is composed of valley silt and alluvium which slopes up gradually toward some soft agglomeratic outcrops some six hundred feet away. The sediments to the right of the stream channel would probably average about 75 feet deep for several hundred feet from the stream. There is no natural place for a spillway as the alluvium in the valley would not stand overpour. Because of the deep alluvial sediments underlying the dam site and the lack of suitable spillway conditions, the site does not appear suitable from a geological viewpoint for the location of a dam.

The *Green Site* (G-G). The height of dam required at this site would be about 55 feet above stream bed. At this location the valley bottom is about 100 feet wide with rather steep bluffs rising up from each abutment. The stream bed is covered with deposits of silt which probably extend at least 50 feet to bed rock. The left abutment shows no massive rock outcrops but is probably composed of soft volcanic material in the form of agglomeratic mud flows or tuffaceous sediments. The right abutment is in part a volcanic lava flow. Its inclination was not ascertained but it extended up the slope of the hill for about 200 feet. The rock appears to be an andesite and is badly fractured, breaking up into fragments about six inches in diameter. The rock breaks down with a slaty cleavage and the soundness of the mass is questionable. The alluvium in the bottom is not suited to an overpour spillway while the right abutment is steep and high and an open cut spillway would probably be costly. The stream bed appears to be overlain by a considerable thickness of sediments. The general conditions

from a geological viewpoint do not give a favorable impression for the construction of a dam at this location.

The *K-K Site* (at the Allen place) is the middle one of the seven sites that were examined. Its position on the government topographic sheet shows it to lie at the edge of a wide alluvial valley but the topography and alignment of the stream channel is very inaccurate as shown on the government map.

At this site a 50-foot dam would create the required storage. The site is immediately downstream from the confluence of a side ravine with the Pit River. This side wash has probably added considerable detrital material to the alluvium at the dam site. Along the bank of the terrace through which this side drainage has scoured its channel is an exposure of tough tuff which seems to represent the underlying formation of the terrace that forms the right abutment of the dam. The extension of the right abutment is rather flat and with the removal of a few feet of overlying terrace gravel would offer a good topographic location for a spillway. If the exposure noted represents the character of the material underlying the entire terrace it appears that available material for the construction of an earth dam could probably be obtained from the spillway excavation. Some protective treatment of the spillway formation would probably be required over the dam abutment.

The channel section at this location is about 100 feet wide which is covered with gravel probably to a depth of 25 feet. The left abutment rises rather abruptly but shows no conspicuous outcrops. It is undoubtedly composed of tuffaceous sediments similar in character to those on the opposite side of the river. The total length of the dam would be about 800 feet. To the right of the channel section there is an eight foot bluff of coarse sediments from the top of which the ground has a gradual slope for about 400 feet.

The relatively low height of dam required at this location and the possibility for an economic spillway over the right abutment together with the use of the excavated material for the body of the dam suggests the serious consideration of this site for an earthen type of structure which might come within the limits of the proposed cost of the project.

The *Lower Bridge Site* at the confluence of Stone Coal Valley about 200 yards downstream from the county bridge. The canyon makes a right angle turn at this location and cuts through a thick bed of volcanic rock. The lava rock appears to be an andesite and at the dam site it is free from its associated tuffs and breccia. The canyon is narrow and the abutments are rather steep with hard massive rock exposed well up on both sides. The stream bed contains no alluvium and gives evidence of a narrow channel about 75 feet wide at the water surface with a few large boulders or slabs of bedrock appearing below the water. The site appears to be a good one geologically. It is narrow and the bedrock is capable of sustaining a concrete structure and resistant enough to withstand overpour. It is my understanding, however, that besides the proposed 70-foot dam which would be required at this location another auxiliary dam would have to be built across a saddle some 800 feet distant from the site. An examination of this saddle shows that it would safely support a concrete structure and would be well adapted to serve as an emergency spillway. A survey of this saddle was requested but the engineers report that this auxiliary dam would make the cost

of the proposed storage prohibitive. From a geological viewpoint this site is the most favorable one of those investigated.

The *Upper Bridge Site* is located immediately upstream and around the bend from previous site. The axis of a dam at this place would be just a few feet upstream from the present highway bridge. The formation here is the same andesitic rock noted at the previous site. The bedrock can be seen nearly across the bottom of the channel with practically no overburden but the abutments are not quite as steep as at the site immediately downstream. There is a drop in the river between these two sites and it is estimated that a 60-foot dam would be high enough at this location. The same auxiliary dam would be required in either case. This site would be suitable for a gravity dam with an overpour section.

The *Overhanging Rock Site* is the uppermost of the seven sites examined. At this location the river has cut its canyon through a thick bed of andesitic lava. Rock is exposed on both abutments and apparently has very little covering in the stream section. The bedrock is capable of standing overpour so that the site suggests a concrete arch, a slab and buttress type, or some overpour structure.

Both abutments were examined but the deep crevices that have worked along some of the fractures throw some doubt as to the suitability of the rock to be stable under end thrusts from an arch dam without considerable excavation. A slab and buttress type, such as an Ambursen dam, is worthy of consideration provided the economic features come within the cost under consideration.

The channel section is flat and practically free of fill material for the bedrock can be followed almost across the entire 300 feet of channel section. The left abutment rises almost vertically for upward of a hundred feet, but it is traversed by several deep vertical fissures. The limited height of dam at this location on account of flooding a large stretch of highway is an economic feature that enters into the suitability of this site aside from the cost of the structure itself.

PUBLICATIONS

of the

DIVISION OF WATER RESOURCES

PUBLICATIONS OF THE

DIVISION OF WATER RESOURCES

DEPARTMENT OF PUBLIC WORKS

STATE OF CALIFORNIA

When the Department of Public Works was created in July, 1921, the State Water Commission was succeeded by the Division of Water Rights, and the Department of Engineering was succeeded by the Division of Engineering and Irrigation in all duties except those pertaining to State Architect. Both the Division of Water Rights and the Division of Engineering and Irrigation functioned until August, 1929, when they were consolidated to form the Division of Water Resources.

STATE WATER COMMISSION

First Report, State Water Commission, March 24 to November 1, 1912.

Second Report, State Water Commission, November 1, 1912, to April 1, 1914.

*Biennial Report, State Water Commission, March 1, 1915, to December 1, 1916.

Biennial Report, State Water Commission, December 1, 1916, to September 1, 1918.

Biennial Report, State Water Commission, September 1, 1918, to September 1, 1920.

DIVISION OF WATER RIGHTS

*Bulletin No. 1—Hydrographic Investigation of San Joaquin River, 1920–1923.

*Bulletin No. 2—Kings River Investigation, Water Master's Reports, 1918–1923.

*Bulletin No. 3—Proceedings First Sacramento-San Joaquin River Problems Conference, 1924.

*Bulletin No. 4—Proceedings Second Sacramento-San Joaquin River Problems Conference, and Water Supervisor's Report, 1924.

*Bulletin No. 5—San Gabriel Investigation—Basic Data, 1923–1926.

Bulletin No. 6—San Gabriel Investigation—Basic Data, 1926-1928.

Bulletin No. 7—San Gabriel Investigation—Analysis and Conclusions, 1929.

*Biennial Report, Division of Water Rights, 1920–1922.

*Biennial Report, Division of Water Rights, 1922–1924.

Biennial Report, Division of Water Rights, 1924–1926.

Biennial Report, Division of Water Rights, 1926–1928.

DEPARTMENT OF ENGINEERING

*Bulletin No. 1—Cooperative Irrigation Investigations in California, 1912–1914.

*Bulletin No. 2—Irrigation Districts in California, 1887–1915.

Bulletin No. 3—Investigations of Economic Duty of Water for Alfalfa in Sacramento Valley, California, 1915.

*Bulletin No. 4—Preliminary Report on Conservation and Control of Flood Waters in Coachella Valley, California, 1917.

*Bulletin No. 5—Report on the Utilization of Mojave River for Irrigation in Victor Valley, California, 1918.

*Bulletin No. 6—California Irrigation District Laws, 1919 (now obsolete).

Bulletin No. 7—Use of water from Kings River, California, 1918.

*Bulletin No. 8—Flood Problems of the Calaveras River, 1919.

Bulletin No. 9—Water Resources of Kern River and Adjacent Streams and Their Utilization, 1920.

*Biennial Report, Department of Engineering, 1907–1908.

*Biennial Report, Department of Engineering, 1908–1910.

*Biennial Report, Department of Engineering, 1910–1912.

*Biennial Report, Department of Engineering, 1912–1914.

*Biennial Report, Department of Engineering, 1914–1916.

*Biennial Report, Department of Engineering, 1916–1918.

*Biennial Report, Department of Engineering, 1918–1920.

* Reports and Bulletins out of print. These may be borrowed by your local library from the California State Library at Sacramento, California.

DIVISION OF WATER RESOURCES

Including Reports of the Former Division of Engineering and Irrigation

*Bulletin No. 1—California Irrigation District Laws, 1921 (now obsolete).

*Bulletin No. 2—Formation of Irrigation Districts, Issuance of Bonds, etc., 1922.

Bulletin No. 3—Water Resources of Tulare County and Their Utilization, 1922.

Bulletin No. 4—Water Resources of California, 1923.

Bulletin No. 5—Flow in California Streams, 1923.

Bulletin No. 6—Irrigation Requirements of California Lands, 1923.

*Bulletin No. 7—California Irrigation District Laws, 1923 (now obsolete).

*Bulletin No. 8—Cost of Water to Irrigators in California, 1925.

Bulletin No. 9—Supplemental Report on Water Resources of California, 1925.

*Bulletin No. 10—California Irrigation District Laws, 1925 (now obsolete).

Bulletin No. 11—Ground Water Resources of Southern San Joaquin Valley, 1927.

Bulletin No. 12—Summary Report on the Water Resources of California and a Coordinated Plan for Their Development, 1927.

Bulletin No. 13—The Development of the Upper Sacramento River, containing U. S. R. S. Cooperative Report on Iron Canyon Project, 1927.

Bulletin No. 14—The Control of Floods by Reservoirs, 1928.

*Bulletin No. 18—California Irrigation District Laws, 1927 (now obsolete).

*Bulletin No. 18—California Irrigation District Laws, 1929, Revision (now obsolete).

Bulletin No. 18-B—California Irrigation District Laws, 1931, Revision.

Bulletin No. 19—Santa Ana Investigation, Flood Control and Conservation (with packet of maps), 1928.

Bulletin No. 20—Kennett Reservoir Development, an Analysis of Methods and Extent of Financing by Electric Power Revenue, 1929.

Bulletin No. 21—Irrigation Districts in California, 1929.

Bulletin No. 21-A—Report on Irrigation Districts in California for the Year 1929, 1930.

Bulletin No. 21-B—Report on Irrigation Districts in California for the year 1930, 1931.

Bulletin No. 22—Report on Salt Water Barrier (two volumes), 1929.

Bulletin No. 23—Report of Sacramento-San Joaquin Water Supervisor, 1924–1928.

Bulletin No. 24—A Proposed Major Development on American River, 1929.

Bulletin No. 25—Report to Legislature of 1931 on State Water Plan, 1930.

Bulletin No. 26—Sacramento River Basin, 1931.

Bulletin No. 27—Variation and Control of Salinity in Sacramento-San Joaquin Delta and Upper San Francisco Bay, 1931.

Bulletin No. 28—Economic Aspects of a Salt Water Barrier Below Confluence of Sacramento and San Joaquin Rivers, 1931.

Bulletin No. 28-A—Industrial Survey of Upper San Francisco Bay Area, 1930.

Bulletin No. 31—Santa Ana River Basin, 1930.

Bulletin No. 32—South Coastal Basin, a Cooperative Symposium, 1930.

Bulletin No. 33—Rainfall Penetration and Consumptive Use of Water in Santa Ana River Valley and Coastal Plain, 1930.

Bulletin No. 34—Permissible Annual Charges for Irrigation Water in Upper San Joaquin Valley, 1930.

Bulletin No. 35—Permissible Economic Rate of Irrigation Development in California, 1930.

Bulletin No. 36—Cost of Irrigation Water in California, 1930.

Bulletin No. 37—Financial and General Data Pertaining to Irrigation, Reclamation and Other Public Districts in California, 1930.

Bulletin No. 38—Report of Kings River Water Master for the Period 1918–1930.

Bulletin No. 39—South Coastal Basin Investigation, Records of Ground Water Levels at Wells, 1932.

Bulletin No. 40—South Coastal Basin Investigation, Quality of Irrigation Waters, 1933.

Bulletin No. 41—Pit River Investigation, 1933.

Bulletin No. 42—Santa Clara Investigation, 1933.

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Biennial Report, Division of Engineering and Irrigation, 1920–1922.

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Act Governing Supervision of Dams in California, with Revised Rules and Regulations, 1933.

Water Commission Act with Amendments Thereto, 1933.

Rules, Regulations and Information Pertaining to Appropriation of Water in California, 1933.

Rules and Regulations Governing the Determination of Rights to Use of Water in Accordance with the Water Commission Act, 1925.

Tables of Discharge for Parshall Measuring Flumes, 1928.

General Plans, Specifications and Bills of Material for Six and Nine Inch Parshall Measuring Flumes, 1930.

COOPERATIVE AND MISCELLANEOUS REPORTS

*Report of the Conservation Commission of California, 1912.

*Irrigation Resources of California and Their Utilization (Bul. 254, Office of Exp. U. S. D. A.) 1913.

*Report, State Water Problems Conference, November 25, 1916.

*Report on Pit River Basin, April, 1915.

*Report on Lower Pit River Project, July, 1915.

*Report on Iron Canyon Project, 1914.

*Report on Iron Canyon Project, California, May, 1920.

*Sacramento Flood Control Project (Revised Plans), 1925.

Report of Commission Appointed to Investigate Causes Leading to the Failure of St. Francis Dam, 1928.

Report of the California Joint Federal-State Water Resources Commission, 1930.

Conclusions and Recommendations of the Report of the California Irrigation and Reclamation Financing and Refinancing Commission, 1930.

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*Booklet of Information on California and the State Water Plan prepared for United States House of Representatives' Subcommittee on Appropriations, 1931.

*Bulletin on Great Central Valley Project of State Water Plan of California Prepared for United States Senate Committee on Irrigation and Reclamation, 1932.

* Reports and Bulletins out of print. These may be borrowed by your local library from the California State Library at Sacramento, California.

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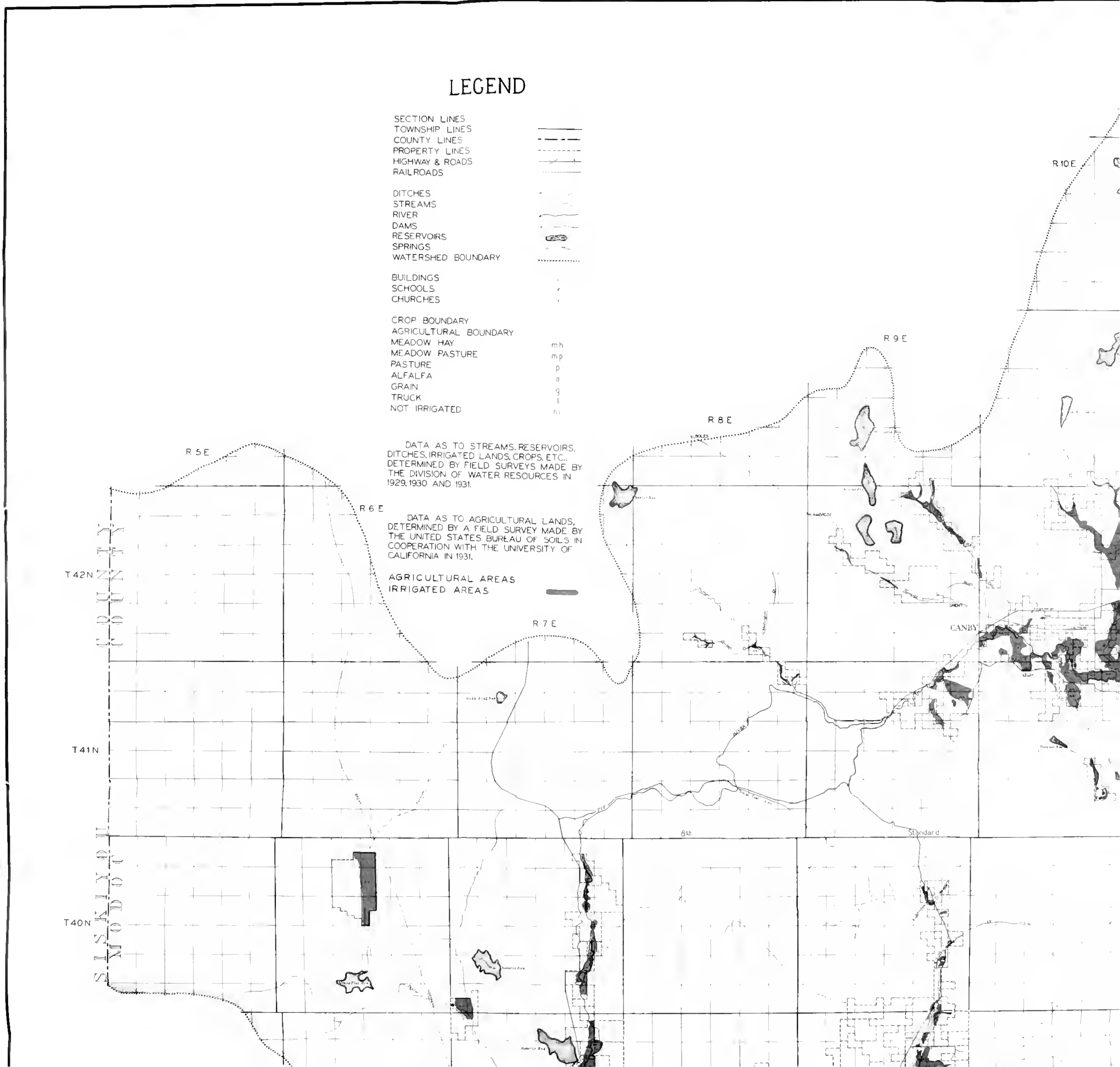
LEGEND
SECTION LINES
TOWNSHIP LINES
COUNTY LINES
PROPERTY LINES
HIGHWAY & ROADS
RAILROADS
DITCHES
STREAMS
RIVER
DAMS
RESERVOIRS
SPRINGS
WATERSHED BOUNDARY
BUILDINGS
SCHOOLS
CHURCHES
CROP BOUNDARY
AGRICULTURAL BOUNDARY
MEADOW HAY mh
MEADOW PASTURE mp
PASTURE p
ALFALFA a
GRAIN g
TRUCK t
NOT IRRIGATED ni
DATA AS TO STREAMS, RESERVOIRS, DITCHES, IRRIGATED LANDS, CROPS, ETC., DETERMINED BY FIELD SURVEYS MADE BY THE DIVISION OF WATER RESOURCES IN 1929, 1930 AND 1931.
DATA AS TO AGRICULTURAL LANDS, DETERMINED BY A FIELD SURVEY MADE BY THE UNITED STATES BUREAU OF SOILS IN COOPERATION WITH THE UNIVERSITY OF CALIFORNIA IN 1931.
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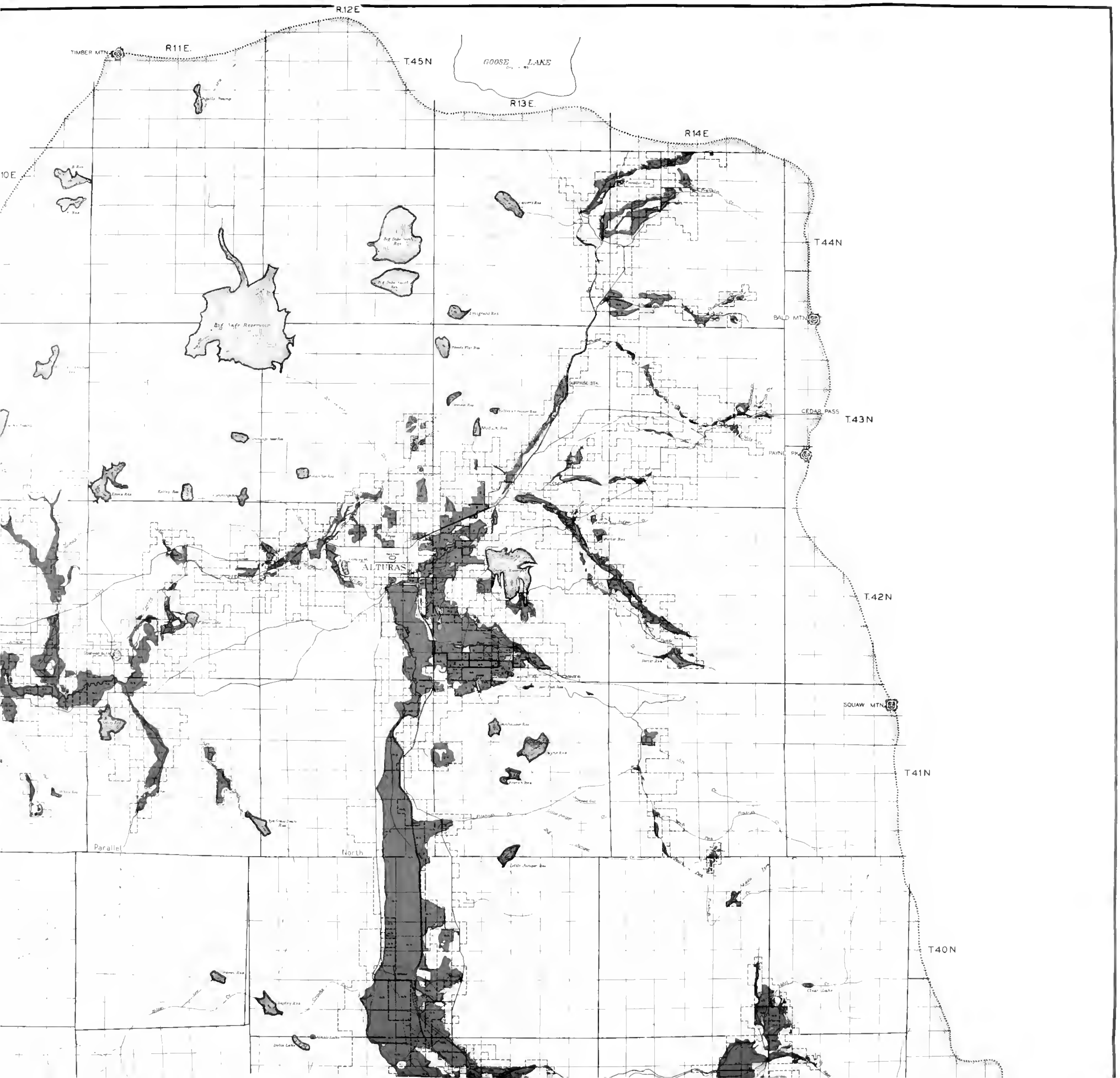
T 40 N
SISKIYOU COUNTY
MODOC COUNTY
CANBY
8th
Standard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TIMBER MTN
T.45N
GOOSE LAKE
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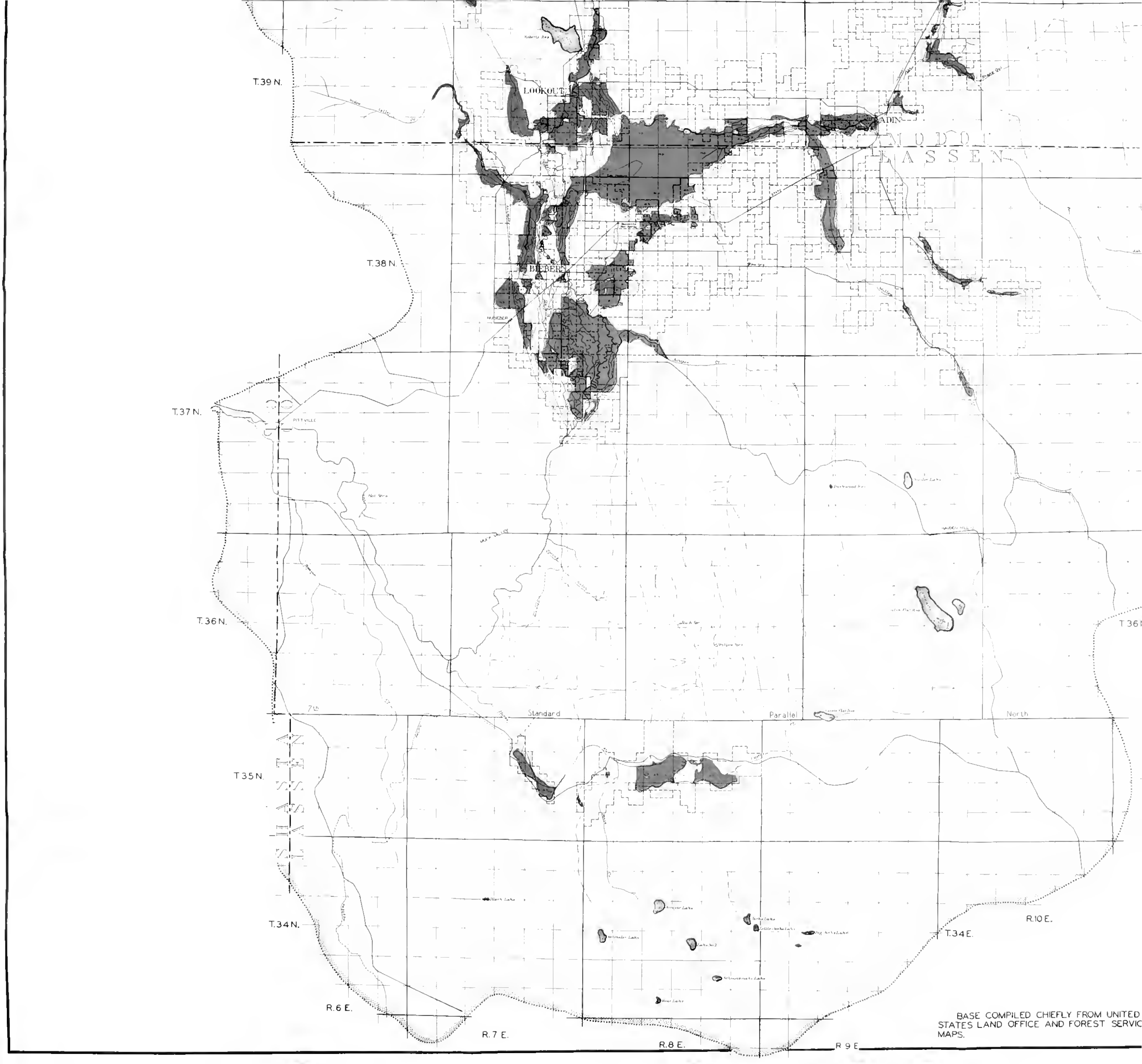
10E.
T44N
BALD MTN
SURPRISE STA.
CEDAR PASS
T.43N
PAYNE PK
ALTURAS
T.42N
SQUAW MTN
T41N
Parallel
North
T40N



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MODOC
LASSEN
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BIEBER
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T.36 N.
7th Standard Parallel North
T.35 N.
SHASTA
T.34 N.
T.34 E.
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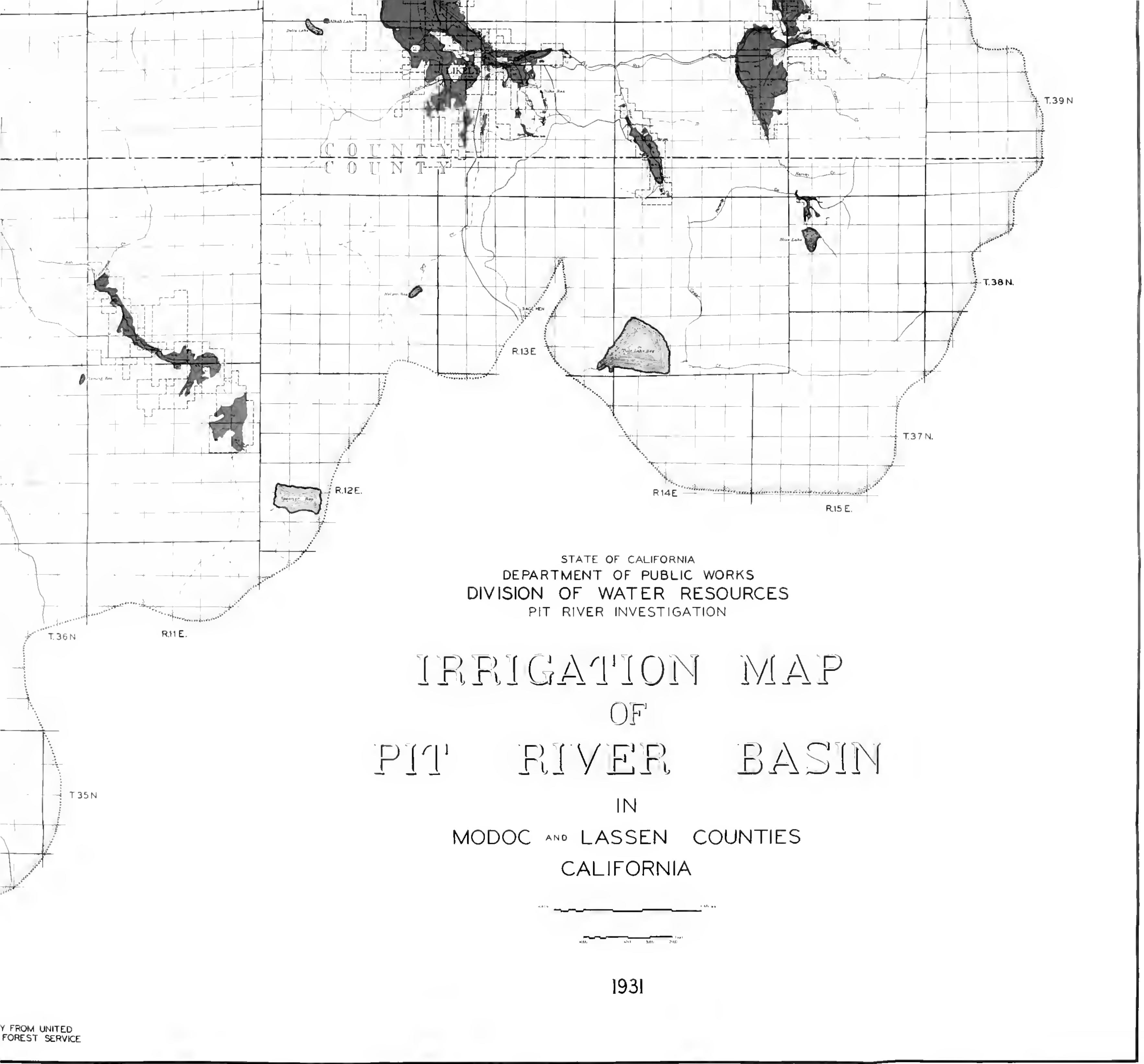
R.7 E.
R.8 E.
R.9 E.
BASE COMPILED CHIEFLY FROM UNITED STATES LAND OFFICE AND FOREST SERVICE MAPS.



STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
PIT RIVER INVESTIGATION

IRRIGATION MAP OF PIT RIVER BASIN

IN
MODOC AND LASSEN COUNTIES
CALIFORNIA

1931